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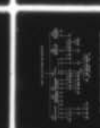
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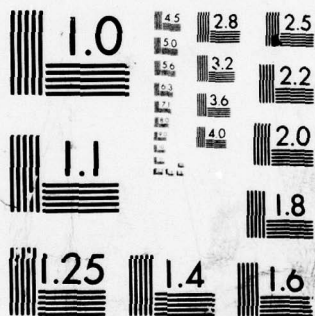
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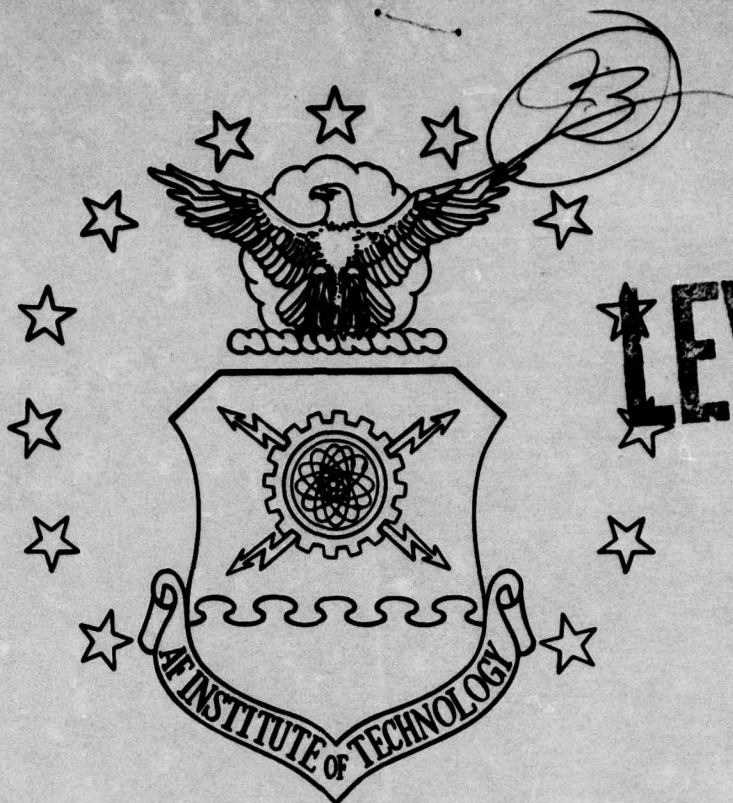
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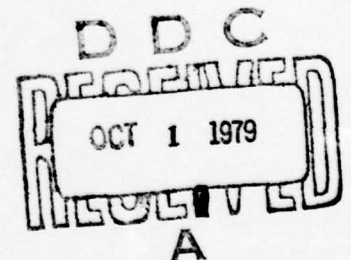
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MANAGEMENT CYBERNETICS: AN APPLICATION
TO STAFF OFFICER REPAIR AND OVERHAUL
DIVISION OF THE ROYAL AUSTRALIAN AIR FORCE

David C. Allard, Captain, USAF
Raymond D. Wilkes, Squadron Leader, RAAF

LSSR 13-79A



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The underlying thesis of this research is that the management cybernetic paradigm, as established by Professor Stafford Beer, is applicable to the Staff Officer Repair and Overhaul (SORO) Division of the Royal Australian Air Force. This was researched by studying the principles of cybernetics, as applied to organizations; and, then by applying them to SORO Division. The authors developed a methodology for analyzing and reviewing SORO Division functions in cybernetic terms. Furthermore, an alternative organization for SORO Division is proposed. The conclusion is that, provided a researcher is cognizant of the cybernetic principles, the management cybernetic paradigm can be applied to other organizations.

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MANAGEMENT CYBERNETICS: AN APPLICATION TO STAFF
OFFICER REPAIR AND OVERHAUL DIVISION
OF THE ROYAL AUSTRALIAN AIR FORCE

A Thesis

Presented to the Faculty of the School of Systems and Logistics
of the Air Force Institute of Technology
Air University

In Partial Fulfillment of the Requirements for the
Degree of Master of Science in Logistics Management

By

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June 1979

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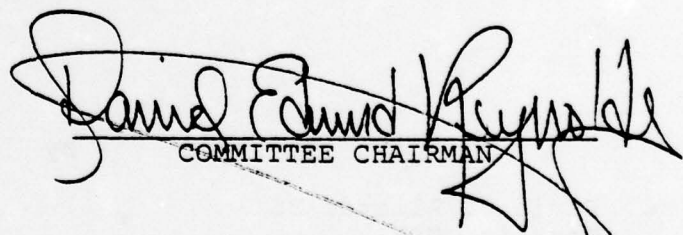
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(INTERNATIONAL LOGISTICS MAJOR)
(Captain David C. Allard)

MASTER OF SCIENCE IN LOGISTICS MANAGEMENT
(Squadron Leader Raymond D. Wilkes)

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Last, but by no means least, to our wives and families, for patience, forbearance and keeping up our morale, we extend our eternal gratitude and thanks.

*[Remember] . . . criticize the style of any book
whatsoever, [but first commit your] . . . criticism to
writing.*

— Thomas Jefferson [20:18]

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CHAPTER I

INTRODUCTION

If engineering and maintenance management is inappropriate, missing, untimely, unforeseeing, inefficient, ineffective, uneconomic, or unsafe, the penalties are direct and real, if not always identifiable and measurable [13:10].

Staff Officer Repair and Overhaul (SORO) Division is a subdivision of the maintenance organization structure of the Royal Australian Air Force. This staff function is performed at Headquarters Support Command (HQSC) where SORO Division is vested with the sole responsibility for depot level maintenance.

HQSC is obviously a system in itself and is composed of many subsystems. However, on a larger canvas HQSC is itself a subsystem of the RAAF as a whole which in itself is a subsystem of the Australian Defence Forces, and so on [15:6].

As an individual organization, SORO Division is important because it is responsible for the control of depot level maintenance; the direction of resources (men, material, money, machines) to depot level facilities; the establishment of a communication link from the various depot level facilities--service, civilian and overseas--to higher levels of the Air Force; and, acts in a coordinative role with other agencies that control resources important to the maintenance of technical equipment.

SORO Division's management functions and its coordinative relationships are complex. It needs sound management of its resources; an awareness of its importance, and the role it is required to fulfill; and the management skills and techniques necessary to cope with increasing technological complexity.

In summary, the RAAF requirement is for a system designed to provide management of maintenance activities conducted at aircraft depots and civilian contractors. At present we have a miscellany of manual systems, where any exists, together with some less than dedicated central supply EDP outputs, working in general isolation and at times disharmony. Visibility, control, accurate forecasting, and measurement of performance can be much improved . . . [13:24].

This reference to dysfunctional management is related to SORO Division as it is the only RAAF organization responsible for depot level maintenance at aircraft depots and civilian contractors. Furthermore, the reference to inadequate manual systems and EDP outputs alludes to a larger RAAF problem that affects SORO Division.

SORO Division is dependent upon manual systems to manage the maintenance of complex engines, aircraft, equipment and their related assemblies. While an EDP system exists to provide management reports, these are usually reporting events that took place days, weeks, and months earlier. Many such computer reports are untimely and inadequate in that they do not report information essential to the manager. For example:

Pipeline times are critical to the total logistic support capability. If the time element is too long, either additional material must be purchased in order to maintain the necessary flow in the pipeline or a stock-out condition will occur at the operational site. In either event, the result will be costly. Reduction of the time element may require additional test and support equipment, personnel, etc., to accomplish the necessary expediting and processing functions. It is desirable to evaluate various elements of the system, identify critical items in terms of need for mission accomplishment, and establish priorities in terms of allowable pipeline times. It is necessary to establish a proper balance between logistics pipeline times, material in the flow, associated logistics resource requirements, and cost. The factors established may have a significant impact on total effectiveness of the system [10:51].

Turnaround time is one of several variables that can be of value to SORO Division managers for their assessment of the system's performance, and their own; however, these are not in use.

The performance of an organization is an important abstract criterion for two reasons. First, it assumes that a standard exists by which to assess the results of an endeavor. Second, it acknowledges that the endeavor is directed toward an objective. Together these constitute the goal/objective orientation of an organization that determines its purpose, or what it is doing.

SORO Division has the goal to support the operational needs of the Air Force through depot level maintenance of RAAF technical equipment (24:Sec.1,Ch.1). This generates the Division's need for continuous on-going strategic (long-term) planning and tactical (short-term)

programming of its tasks. In addition, some means is required to monitor the attainment, or otherwise, of the Division's goals and objectives.

The author's personal experience gained from three years in SORO Division and three additional years in an organization that directly interfaced with SORO Division, has led to the knowledge that this is an unfulfilled expectation. It is generally assumed that individual managers will plan their work, or that they instinctively understand the goal of SORO Division, and instinctively set their objectives. Again, personal observation indicates that for the most part individual and group activities were performed in response to the most recent crisis. "We take 'brush-fire' action to overcome sudden and unforeseen problems and so keep the show on the road, but safe and effective [13:10]." This is, sincerely, referred to as management by exception; however, this misunderstanding does not end with SORO Division, but extends to other support organizations.

Logistics support in turn becomes essentially support of the maintenance function, and this involves close integration of many engineering, maintenance, supply and financial activities, to meet corporate-set goals. However, the current [RAAF] organization places most of these activities in autonomous elements with little, if any, interface. Each is expected to do its part to meet the corporate goal, properly and right on cue, across the specialist [RAAF] organizations. This is expecting too much, in view of the multitude of interacting, and interrelated activities involved, so

decisions tend to be taken in isolation and management becomes an exception affair that usually takes place after a problem arises [12:6].

The distinction here is that this type of management is not "management by exception" within a stable situation, but management by crises.

It is not unreasonable to expect that suborganizations operating in such an environment will exhibit similar characteristic behavior. In addition, an expectation that related divisions are in competition with each other for available resources, has been confirmed during the author's six years experience at Headquarters Support Command. In particular, the following quote is applicable and, even though it is generalizing to the RAAF, it was stated with Headquarters Support Command in mind.

Within the RAAF, the growth in inter-relationships, and frequently inter-dependence, between many specialist branch activities (particularly in the support area) has developed to a point where corporate goals are difficult or impossible to achieve within reasonable time, effectiveness, and economy. The result is usually friction, frustration, and conflict and a demand for more and more resources to cope [12:4].

To summarize, a variety of problems are evident, both internal and external to SORO Division. They range from the lowest level, where daily activities are performed, to the highest level, where policies and strategies are formulated. The reason for such a span is to emphasize that there is no one specific problem in being in SORO Division, but a number of interrelated problems. Some are

generated internally, while others are imposed from the external environment.

The significant point here is that before these problems can be addressed, they need to be viewed in context with the organization's goals and purpose. In a systems sense, a framework is required in which the problems can be properly viewed;

The maintenance of an acceptable support capability and responsiveness within economic constraints will require new management techniques, and necessitate the fading of traditional specialist boundaries that now exist. Advancements in information technology will further contribute to the collapse of the traditional organizational structure and impact considerably on how managers manage. . . . The challenge now is to develop the organizational structure that brings together those essential logistics functions in such a way that they interface with operations and central planning staffs, and, in response to corporate goals, create and sustain the force required, effectively and efficiently [12:7-8].

This quote clearly identifies that the organizational structure is a basic starting point for effecting improved corporate support management. In addition, effort needs to be concentrated on defining organization relationships and interfaces rather than introducing changes that ignore the purpose of the organization, its internal and external relationships and the limited resources available to it. This, also, is equally applicable to SORO Division.

The problems of SORO Division have not been exhausted, but those presented represent the source of other more common organization problems. For example, dysfunctional behavior in the form of low morale,

frustration, political (self-serving) behavior, ineffectiveness, lost opportunities, and poor communication are evident in SORO Division.

An underlying issue here is that of control.

In systems terms, control is not something imposed from a higher center to make things work out right. Instead, control is an integral part of the system being controlled. Once there is structure, as we have defined structure, control becomes self-control and the system more or less organizes itself to effect that control through information flow and feedback mechanisms [14:16].

Control is exerted within SORO Division when it is necessary to resolve a crisis, but on-going self-regulation does not exist. In terms of the quote used, the missing factors are information flow, feedback, and structure. However, in order to discuss the issues of control, self-regulation and feedback, a comprehensive framework of concepts, plus a coherent methodology must be established. These will be developed in succeeding chapters.

Problem Statement

The development so far has emphasized that SORO Division of the Royal Australian Air Force has primary problems that contribute to a collection of secondary problems. An attempt to resolve these without recognizing their origin leads to solutions that are ineffective. The more important task is to determine the boundaries of SORO Division and establish a framework in which to not only

develop solutions, but to ensure that it continues to operate over a range of changing circumstances.

Hence, the situation confronting the research team is that a prescription for the design and development of SORO Division is needed, but does not exist. This leads to the problem for research. It is: the need to develop a conceptual organization design for SORO Division such that it will remain viable and adaptive to perturbations from its external environment, and maintain its internal stability. The thesis of the research team is that such a design is possible.

Justification of the Research

This research can be justified by the importance of SORO Division as the sole repair and overhaul division within the Royal Australian Air Force, and the responsibility it has for the authorization and management of 750 thousand manhours of work to three aircraft depots and \$AUS 30 million of work to Australian defense industries (24).

Justification of the research is established on the premise that an inefficient, or ineffective maintenance arm will detract from Australia's air defense capability (2:Part 2,1). This effect is undesirable. In addition, the research can be further justified from a strategic viewpoint, that without an air force or Australian defense

industry maintenance capability, an alternative overseas maintenance venue will be required. This will create logistic support problems, and increase Australia's vulnerability. In a strategic context, this is undesirable.

Furthermore,

. . . one of the most critical factors [in the future] will be the allocation and use of financial resources. Fewer dollars will be available and proven value for money will be demanded [12:7].

SORO Division, then, will need to be both efficient and effective in its use of resources made available to it. Hence, the research can be further justified on the need for the economic and effective use of resources.

Scope of the Research

The scope of this research is limited to the conceptual application of a management cybernetic paradigm to Staff Officer Repair and Overhaul (SORO) Division at Headquarters Support Command of the Royal Australian Air Force. The management cybernetic paradigm referred to is that developed by Stafford Beer in his books Brain of the Firm (4), and Decision and Control (6).

Research Objectives

The objectives of the research can be stated in the following terms:

1. To establish a methodology for the application of Stafford Beer's management cybernetic paradigm.

2. To apply Stafford Beer's management cybernetic paradigm to the Staff Officer Repair and Overhaul Division of the Royal Australian Air Force.

3. To propose an organization design for SORO Division in terms of the management cybernetic paradigm.

Research Questions

Consistent with the problem statement and research objectives, the following research questions are posed:

1. Is it possible to prescribe an organization design for SORO Division in terms of the management cybernetic paradigm?

2. What specific structural changes are required to ensure that SORO Division processes are maintained or enhanced by the introduction of management cybernetics?

3. How can SORO Division's performance be measured?

CHAPTER II

SELECTED PRINCIPLES OF CYBERNETICS

The main discovery of cybernetics after a history of twenty-five years, and indeed what gives it the right to be called a coherent science, is that these are fundamental principles of control which apply to all large systems.

— Stafford Beer [4:32]

The previous chapter outlined the problems of SORO Division to emphasize the range of problems and the complexity that its managers are required to comprehend. Such complexity cannot be resolved through simple management, platitudes and models. It requires a complex comprehension of the organization's situation, and the careful application of scientific principles. The application of scientific knowledge to management is different to the application of scientists to the problems of management.

The scientist qua scientist seeks only to do science. But the OR [Operational Research] scientist has a special motivation towards science in management, usually [one observes] because he cannot bear to look on quietly while decisions are taken, strategies adopted and controls instituted in important enterprises on the basis of guesswork [6:91].

This research is based on cybernetic principles that have evolved from scientific research. In order to comprehend the research that has been undertaken, these principles need to be understood. Therefore, the purpose

of this chapter is to provide an awareness of the cybernetic principles and concepts operative in this research.

The Principle of Cybernetics

For if cybernetics is the science of control, and if management might be described as the profession of control, there ought to be a topic called management cybernetics--and indeed there is. It is the activity that applies the findings of fundamental cybernetics to the domain of management control [25:303].

Management cybernetics conceives of the whole organization as a purposeful control system that functions through communications (25:306). This communication must operate not only within each recursive niveau, but also with the adjacent niveaus to ensure a complete and meaningful information system within the organization.

It is only through this information system that the organization can hope to apply the principles of cybernetics, which states: "Control is that function of the system via which a critical variable of system behaviour is held at a desirable level by a self-regulating mechanism [25:307]." It is the function of the focal niveau, through effective communication channels, feedback, and homeostasis, to provide the control necessary to ensure its divisions perform at a desirable level within the organization.

This principle is the fundamental starting point underlying the research thesis. Without the sense of need for control in the manager's world there would be no requirement for control. This issue is made all the more

critical since technology brings complexity which the manager must control. However, the role of the manager here needs to be stressed: "The manager is the instrument of change [otherwise, what is he doing?] which is to say his job is that of control [4:31]." So, technology introduces complexity, but only at the behest of the manager who, in turn, must recognize his need to control the change that it precedes.

Ashby's Law of Requisite Variety

. . . control can be obtained only if the variety of the controller (and in this case of all the parts of the controller) is at least as great as the variety of the situation to be controlled [4:54].

The appropriate amount of control for any organization is embodied in Ashby's Law of Requisite Variety which is derived from Shannon's Mathematical Theory of Communication (29:505). This law states that in order to control a system, a controller must be capable of taking at least as many distinct measures or countermeasures as the system, the controller seeks to control, may exhibit (29:136). That is, there is a need to make the information processing capability of the managers compatible and comparable with the information presented by the system to be controlled.

A system's complexity can be evaluated in terms of the different situations (states) it can have. As the number of variables in the system grow, so does its complexity. For each action (or stimulus) received from the

system, the controller must react (provide a response) (29:505). Control, therefore, means to be able to cope with system variety--to choose the appropriate measure among all those possible that will counter the actions of the system.

To obtain complete control of a system, a controller must have three abilities:

1. At least as many distinct available alternatives as the system can exhibit.
2. The precisely correct set of alternatives, within the set available, to counter those generated by the system.
3. The processing ability to use those distinct actions at a rate at least equal to the system to be controlled (29:505).

How does a manager reduce the variety or uncertainty of a system? The answer is: through information (25:72). Information extinguishes variety and the reduction of variety is one of the techniques of control, not because it simplifies the system, but because it makes the system more predictable (25:73). As Ashby states, "only variety can destroy variety [25:74]."

Seldom in the real world does one possess requisite variety; yet one operates as if one had total control. What usually happens is that an attempt is made to develop variety for only those factors (variables) that have a high

probability of occurrence. Factors with a low probability of occurrence are given scant attention until some event justifies their further attention.

Variety; its generation and attenuation, is a pervasive factor in managing complexity:

The major thread unravelled by management cybernetics is the thread of variety . . . its filtering and control. [It is] . . . when we make our models and classify our insights in terms of variety that we perceive what management is really about [4:290].

The Concept of Homomorphism

Can we see the order of the parts of the universe, the subordination among them, and notice how so many different things compose such a permanent whole, and remain convinced that the cause of the universe is a principle without any knowledge of its effects, which without purpose, without intelligence, relates each being to particular ends, subordinated to a general end [25:5].

The notion of hierarchy is fundamental to man and is evident in a variety of forms. A common example is the structure of organizations.

There are distinct reasons for the popularity of hierarchically organized man-made systems. Particularly, the task of managing a complex enterprise is generally considerably simplified when that enterprise can be broken down into sub-systems, just as a complex problem is generally solved by breaking it into subproblems that are, individually, more analytically tractable. There are reasons of efficiency as well [28:49].

In cybernetics, the notion of hierarchy is related to homomorphism, cones of resolution, and the principle of recursion. Homomorphism is the process of relating a larger set of elements to a lesser number of elements of another

set, without losing the correspondence of the first set to the second set (6:108). In the abstract form, this principle of homomorphism is not so clear, but expressed in a simpler form, it is a "many-to-one" reduction process. If the correspondence of the first set to the second set remains identical, an isomorphic relationship exists (6:107-119).

A cone of resolution is a cone that delimits levels of abstraction. The apex of the cone represents the highest level of abstraction, with its complement--low resolution; conversely, the base of the cone represents the lowest level of abstraction, with its complement--high resolution (25:247-248).

The importance of these two concepts is that they are abstract thinking tools that enable a manager to proceed from a high level of abstraction to a more concrete, low level of abstraction, while still preserving a many-to-one (homomorphic) correspondence between various levels. The application of these concepts focuses on the need to better understand the relationship of maintenance to logistics; its place in the Air Force; and, the relationship of SORO Division to depot level maintenance.

The Principle of Recursion

But they are all the same. They nest inside each other, and they are linked by the definition of autonomy, which is guaranteed for each level of recursion by the one above [9:7].

The principle of recursion as proposed by Stafford Beer states: "If a viable system contains a viable system, then, the organizational structure must be recursive [4:287]." It can be expressed in an alternative manner. If an organization is a viable organization, then its suborganization and the suborganization's suborganization, on down to the individual person within the lowest level of the organization, will be viable and, therefore, a whole system in itself.

This principle is important in that it is a powerful thinking tool that enables complex relationships to be seen more clearly. Consider the complexity of enterprises, industries and their relationship to the economy. Enterprises are horizontal components of an industry, which itself is conceived as a vertical component. Now advance a level of recursion. Here there are industries as horizontal components, and something called a branch of industry (such as "light" or "heavy") as the vertical component. Advance to the next level of recursion. The branches are now horizontal components, and the vertical component is total industry itself. (At a further level of recursion, industry joins agriculture, transportation, health, education, and so on, as a horizontal component of something called the economy (9:7)). In fact, the levels of recursion represent a hierarchy of functions and processes which can be visualized as forming a cone of resolution.

As the grouping of each successive level becomes more abstract, a degree of resolution is forfeited; conversely, as groupings become less abstract (more concrete), a degree of resolution is gained. This is important to understand as it provides a consistent means of moving from high levels to low levels of abstraction, and still maintain a coherent, or corresponding, connection between them. This principle of recursion can be applied in a variety of situations involving high level abstraction processes--whether they are concrete or cognitive.

The application of this principle allows study to be concentrated in the specific area (level of resolution) without violating the cybernetic principle of holism. To illustrate this principle: Figure 1 represents a complex organization with multi-levels of hierarchy. Each of these levels is called a niveau to distinguish between levels of recursion within the organization structure in order to avoid possible confusion with the particular concept of "level" within a given niveau (5:82).

The Level I niveau represents the highest level of viable systems. Level II represents a lower level of abstraction for a selected viable system. Level III represents another lower level of abstraction, but relative to the Level II niveau. These niveaux and their respective viable systems can be visualized as three levels of management, with each having its own set of functions and

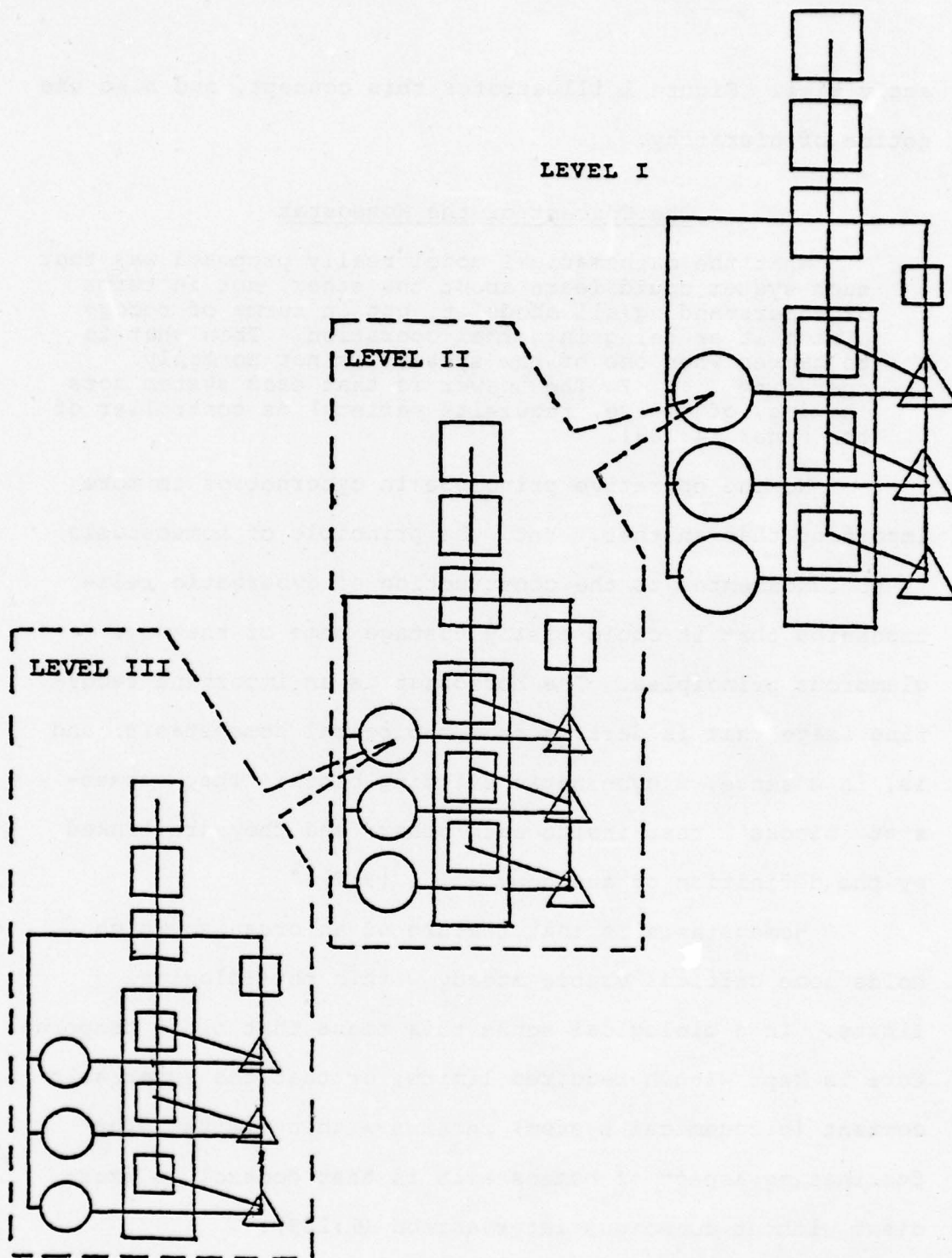


Fig. 1. Levels of Recursion [5:199]

activities. Figure 1 illustrates this concept, and also the notion of hierarchy.

The Concept of the Homeostat

What the mathematical model really proposed was that each system could learn about the other, not in terms of understanding all about it, but in terms of recognizing it as being in normal operation. Then what is to happen when one of the systems is not normally operating . . . ? The answer is that each system acts (having, of course, requisite variety) as controller of the other [4:186].

No one operative principle in cybernetics is more important than another. Yet, the principle of homeostasis is so fundamental to the construction of cybernetic relationships that it could easily upstage some of the more glamorous principles. The homeostat is an important recurring image that is derived from biological homeostasis; and is, in a sense, a cybernetic building block: "They [homeostat 'blocks'] rest inside each other; and they are linked by the definition of autonomy . . . [9:7]."

Homeostasis is that feature of an organism which holds some critical viable steady within physiological limits. In a biological sense this means that blood temperature is kept within required limits, or that the sugar/salt content (biochemical system) remains within limits. The fascinating aspect of homeostasis is that control is exercised without conscious intervention (6:289).

A formal account of homeostatic equilibrium has been produced by Ross Ashby, a notable systems thinker and

cybernetician. Ashby discovered the principles underlying homeostasis by building a strange machine which he called the homeostat (6:290). This machine had only one object: to settle down as quickly as possible to a stable condition after it had been disturbed.

The homeostat is therefore a mechanism for achieving stability--the constancy of some critical variable [its output]. [But] . . . Ashby was in fact chasing a more elusive concept, which he called ultrastability. In ordinary language, an ultrastable system is capable of resuming a steady state after it has been disturbed in a way not envisaged by its designer [6:290].

It is not the intention to explain precisely how the homeostat functions, but to mention that the management cybernetic paradigm is a series of interrelated homeostats; and each is ultrastable (9:7). The recognition of homeostatic relationships in management systems represents a fundamental starting point in the cybernetic analysis of systems.

A system that is able to accomplish this stability in the face of environmental changes (or exogenous perturbations) is generally referred to as a homeostatic system. Homeostatic systems are all predicated on a closed-loop configuration that allows a constant feedback between system and environment (as in a thermostat or the mechanisms that regulate body temperature in animals). The ability to maintain the character of a system, much less its specific properties, in the face of adverse forces, is a much valued one, and one that has been of considerable interest to system scientists . . . [28:69].

The important feature about the concept of homeostasis is that it holds a relationship of factors (variables) within acceptable limits. This holds true for

biochemical systems, biological systems, and gives credence to its application to social systems.

The principles and concepts presented have been especially selected because they represent the important ones to assimilate, early; and also, because they have been used in this research. Their particular use and application to SORO Division is further explained in the chapter concerned with methodology.

CHAPTER III

METHODOLOGY

The Management Cybernetic Paradigm

For unless the point is taken that something has to be done, the upheaval imposed by the remedy (however attractive it may look in its own right) will seem too much.

— Stafford Beer [4:246]

The management cybernetic paradigm developed by Stafford Beer and presented in his book Brain of the Firm (4), is the key source of the methodology adopted for this thesis. Previous discussion has highlighted several fundamental concepts and principles of cybernetics. It is time to address the model that coalesces these into a meaningful set of systems which enables an organization to remain viable and ultrastable (the ability to recover from unexpected perturbations) (7:77).

In today's world of increasing technological complexity, control of management processes is still as important as it was to Frederick Taylor (19:55,72). In some ways, it may be even more important because technology signifies complexity, and complexity and change are important for managers to control.

"Underlying the problems of good practice in the modern firm are the problems of control, and underlying

these in turn is the problem of control to what end [4:32]?" There are two issues here. First, what do managers recognize as needing control? Second, what is the purpose of exercising control?

Traditional managers normally consider the first issue with little awareness of the second. Yet it is the second issue, which is related to the organization's purpose, that often predetermines the processes to be controlled (14:1-5).

The existence and survival of many organizations demonstrates that control is being exercised; but, is it performed as a haphazard function, or is it a conscious action of managers, as directed by management toward the achievement of corporate objectives? The question is simply expressed, but its answer is not as simple.

An understanding of the application of cybernetics to social systems (complex organizations) is difficult to grasp without a knowledge of cybernetics; however, the reader is invited to observe the end result of Stafford Beer's study in this area; namely, the cybernetic paradigm. It is stressed at this point that the paradigm represents a system of homeostats for the control of those management functions and information flows of the organization considered necessary to its survival or viability. Therefore, the management cybernetic paradigm should be viewed as being applicable to a variety of situations, and not as a model,

which only represents a selected abstraction of reality (6:101). By viewing the paradigm as something more than a model, it is possible to gain a better appreciation of its importance.

The paradigm presents what is believed to already exist in organizations, but which is not easily recognized because of fragmentation. In fact, it is presented that all viable organizations are really like this already. Therefore, the value of the paradigm is to make clear how the organization actually works, so that it may be streamlined and made more effective (4:198).

An Overview

The management cybernetic paradigm presented by Stafford Beer comprises five interrelated homeostatic systems that are genetically reproducible at both higher and lower niveaux (4:200). The systems can be described as follows:

1. System One--the Operational Unit which is comprised of a Division and its Divisional Regulatory Center.
2. System Two--Integral Control which is comprised of Divisional Regulatory Centers and a Corporate Regulatory Center.
3. System Three--the Operations Directorate.
4. System Four--the Development Directorate.
5. System Five--the Board Level.

These five systems are arranged in the same sequence as the system numbers. The actual configuration is shown at Figure 2.

Each system of the paradigm has been established from its analogous counterpart in the human neurophysiology (6:114). Therefore, the credibility of such a relationship of systems is supported by the viability and adaptability of man himself (4:199). Hence, it should be noted that the paradigm is not the normal line of authority structuring represented in Weber's concept of bureaucracy. More significantly, it represents the structure of control and information flow necessary to the organization's survival.

System One--Operational Unit

System One comprises two important components; a Division, and a Divisional Regulatory Center. The former is concerned with the performance of the functions¹ and activities² necessary to meet organization goals. The latter is concerned with the monitoring and filtering of input data received from the Division. Relevant data are used at the corporate levels (Systems 3, 4, and 5) of the organization. Furthermore, the Divisional Regulatory

¹Function is (a) the natural or proper action for which a person, office, mechanism, or organ is fitted or employed; (b) assigned duty; and (c) specific operation or role.

²Activity is (a) a specified form of supervised action; and (b) the state or condition of being active [1:13].

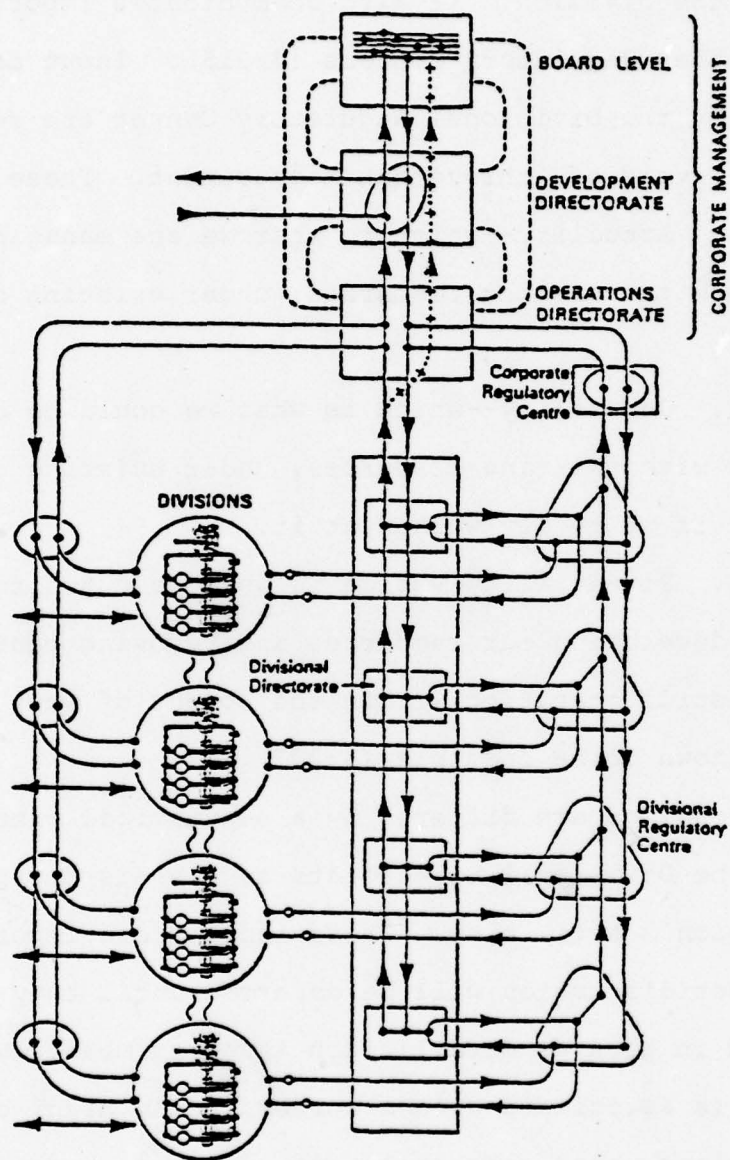


Fig. 2. The Management Cybernetic Paradigm
[4:199]

Center assumes responsibility for strategic planning by objectives, tactical programming, and the normative planning for the Division. It also communicates important data to other Regulatory Centers (4:216). Input data received by the Divisional Regulatory Center are related to three levels of achievement measurement. These are:

1. Actuality--which is what we are managing to do right now with existing resources, under existing constraints.

2. Capability--which is what we could be doing right now with existing resources, under existing constraints, if we really worked at it.

3. Potentiality--which is what we ought to be doing by developing our resources and removing constraints, although still operating within the bounds of what is already known to be feasible (4:207).

Daily recordings are filtered by a statistical process and used by the Divisional Directorate as a basis for planning the division's activities. These indices are important, but further discussion will be deferred until they can be discussed in greater detail; each level of measurement (the indices) is associated with a corresponding plan, or three sets of plans which separately employ these three criteria (4:207).

Planning on the basis of actuality is called programming, while planning on the basis of capability is called planning by objectives. Planning on the basis of potentiality is called normative planning.

The first of these is simply a programme because it accepts the inevitable shortcomings of the situation, and does not admit that anything can imminently be done about them. We move to genuine planning only when we set new objectives and try to achieve them. This is the strategic planning level. Normative planning sets potentiality as its target--and incurs major risks and penalties, although it also offers major and perhaps decisive benefits [4:208].

Figure 3, the organization of divisional management--System One, illustrates this description.

It is important to keep in mind that Figure 2 represents one niveau. There will be others that interconnect with lower and higher niveaux. Each niveau will look the same, diagrammatically, but will have different variables. These may or may not be of interest to other niveaux. This is reasonable, since each niveau functions as an autonomous (self-regulating) body (9:7).

. . . each level of recursion has its own set of critical variables, monitored at its own level. None has any direct information about imminent crisis at the level below; because the alarms have been sent back at that lower level, and only the raw data have been transmitted upward, in order to quantify the higher level systemic models [9:13].

The importance of this quote will not be clear yet. However, it is revealing that each niveau manages itself in terms of the indices it has chosen. If an indice indicates a problem, the organization attempts to resolve it at the

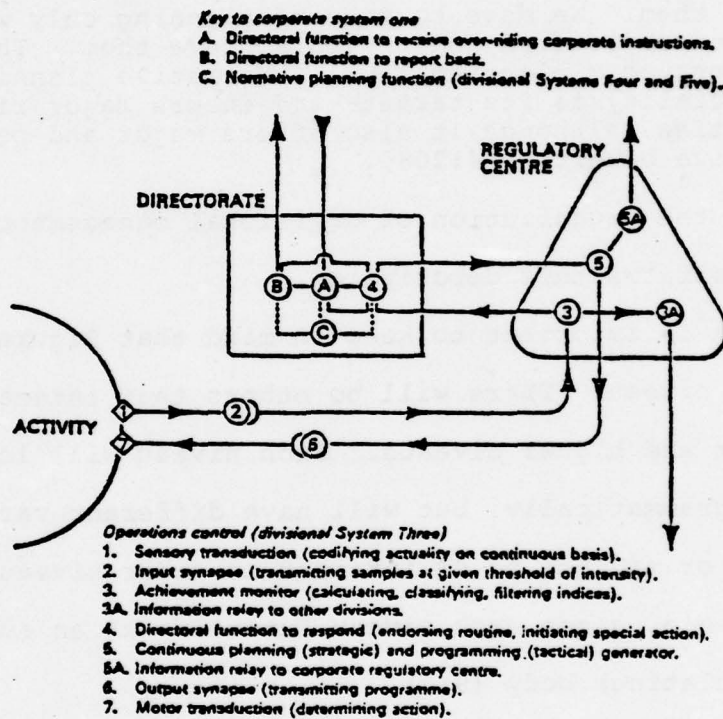


Fig. 3. Organization of Divisional Management--
System One [4:216]

lowest level (Divisional Directorate), and if not there, then on to the next system (say, Corporate Regulatory Center). When the problem remains unresolved, beyond a time limit, a request for help is generated, possibly to a higher niveau.

When a signal forewarning a change for the worse was sent out, at any level of recursion, the clock for that variable was started. Cyberstride [the statistical program used in Chile to produce indices] would then look out for a recovery of this indicated variable. If the recovery did not appear before the clock ran out a [signal] . . . would automatically pass up to the next higher level of recursion--announcing a need for help. In this way, it is possible in theory that the President's [Allende] economic committee would eventually hear of the ineffectiveness of a limestone crusher somewhere in the north [9:14].

The principle of recursion is powerful, not only as a cognitive tool, but in practice as well--as this small example illustrates.

System One requires a detailed information source and service to relate the organization's daily activities, and it needs optimizing programs capable of two main roles. The prior role (mathematical programming) to deal with the input-output analysis. This involves a given range of resources and tasks, and determining the best allocation of resources relative to cost-minimizing criteria. The second role, stochastic programming, deals with the interactions, not of fixed quantities, but of probabilities. These two roles can be illustrated by considering the risk that a particular spare part will be required, and the

chance that it will be available. The interaction of these two factors determines the optimal stock level under any given criterion of risk that the stock will run out. These two roles (mathematical and stochastic programming) are most important because most of the problems in System One turn out to be some amalgam of rigorous optimizations and the calculation of risk. Hence, the tool to use here is applied statistics (5:35).

System Two--Integral Control

System Two--Integral Control is closely involved with the mechanism of System One--Operational Unit. Therefore, careful thinking is needed to not confuse the latter with the former. A brief summary of System One is appropriate.

System One has three major components; the Division, the Divisional Directorate, and the Divisional Regulatory Center. Data related to daily activities is passed to the Divisional Regulatory Center. These data are processed to form the measures of achievement which can be assessed in terms of the Directorate's plans. Values of the indices are communicated to the various divisions, through their respective regulatory centers. By this means, each division is informed of the other's performance. In addition, the Corporate Regulatory Center is informed--not for just one division, but for each of the divisions. In this way,

the purpose of System Two is to filter and communicate the respective indices of each Division to System Three--Operations Directorate, for further analysis. In so doing, System Two acts in a way that reduces the effects of a Division over-reacting to the performance of any one, or all, of the Divisions.

Note, that each Division attempts to optimize a solution to its own problems. However, there is conflict between the inputs from the other Divisions, and the Division's own perception of the action required to correct the situation. In fact, a Division cannot optimize its own problem solutions without some impact on the other Divisions. These tend to cause the other Divisions to compensate and change their solutions, and soon the system is out of balance in trying to cope with constantly changing situations. The unstable System One behavior requires a higher level control function to integrate the solutions of each Division, and to regain stability (4:222). It is the function of System Two to meet this need. System Two comprises two components; all the Divisional Regulatory Centers, and the Corporate Regulatory Center. It should be added that information from the Divisional Regulatory Center passes through the Divisional Directorate before going to the other Divisional Regulatory Centers and the Corporate Regulatory Center.

Each of the Divisional Regulatory Centers process data from their respective Divisions to produce the indices necessary for the Divisional Directorate's planning purposes, and assessment of performance. In turn, the Division's indices and performance are communicated to each of the other Division's regulatory centers. This information is in the form of a number between zero and one.

Earlier, discussion referred to the achievement indices of actuality, capability and potentiality. These have related indices:

1. Productivity--which is the ratio of actuality and capability.
2. Latency--which is the ratio of capability and potentiality.
3. Performance--which is both the ratio of actuality and potentiality, and also the product of latency and productivity.

The simple elegance and importance of these indices is significant. Within six indices (including the three from which these are derived) the management can gain a real-time appreciation of its performance; its productivity; and its latency. Performance is something that most managers talk about, without being able to establish in any lasting way; likewise, with productivity. In addition, latency is discussed in terms of investment; but, seldom in traditional management, is it clear where the best

investment opportunities exist. By skillful use of these indices, it is possible to see the best investment opportunity (8:436). The use of these indices is outside the scope of this section, but they are mentioned to emphasize their importance and that they represent more than a number ratio.

These indices are produced by each Divisional Regulatory Center. The function of the Corporate Regulatory Center is to process all the indices from the respective Divisions and inform System Three of any changes (4:223). It is the function of System Three to take the corporate view and use the indices to determine changes in the allocation of resources, plans, and to decide the best investment for the capability and latency of the organization. Therefore, System Three communicates with the Corporate Regulatory Center.

Perhaps the main point of the System Two arrangement is its automatic simplicity, and therefore its speed. For example, the message that "something has changed, and like this" goes simultaneously from the Divisional Regulatory Center to (1) the Divisional Directorate, (2) other regulatory centers, and (3) the Corporate Regulatory Center--then on to System Three, if required.

The job of the Divisional Directorate is first and foremost to discover what went wrong, what made this happen, and to devise measures to put it right.
. . . So the Divisional Regulatory Centre has

re-programming to do. The other Divisions have consequences to draw, and reports to make quickly to the Corporate Regulatory Centre. That centre itself has to take fast corrective action, either through its regulating machinery, or (if managerial prerogatives are involved) via System Three and the command axis [2:223].

At this point it is best to go on and discuss System Three--but not without first noting that ". . . our age has produced so many large-scale organizations without a System Two [4:224]." Hence, the emphasis on the importance of System Two.

System Three--Operations Directorate

System Three--Operations Directorate is the first system in the corporate management level. The significance of this special claim is that Systems One and Two are concerned with the performance of the individual Divisions--which do not behave in a way that considers the whole or corporate nature of the organization. This, then, is the function of System Three: to govern the stability of the internal environment of the organization, and to adopt the corporate view (4:224). It achieves this through information transmitted to it from the Corporate Regulatory Center, and in conjunction with information communicated to it from System Four--Development Directorate.

System Three has four interfaces: (1) System Two--Divisional Directorate which includes the Corporate Regulatory Center; (2) System One--Operational Unit which receives

directions from, and passes information to, System Three; (3) System Four--Development Directorate--passes information about plans, policies, and the environment to System Three, which transmits corporate information to System Four; and (4) an Audit Ganglion which assists the corporate System Three to instigate an internal audit (though not simply financial). The Audit Ganglion acts to acquire and process information from each of the Divisions which aids the corporate synergy. In addition, it helps to supplement the information received by System Three from the Systems One and Two--simply because every other kind of reporting upward fails to comprehend all the information needs of System Three which arise beyond the pre-arranged routines of Systems One and Two (4:224-227).

There is one aspect though, in which [System] 3 should have direct contact with [System] 1, and that is what could be called "Auditing and Emergency Action," at the niveau of the firm, or parasympathetic control at the niveau of the individual (person). Under "auditing" one tries to express the need of [System] 3 to check if messages coming from [System] 2 are not leaving out something important. . . . Typical symptoms to look after are: people's dissatisfaction, financial abuses, excessive waste, customer's complaints and so on. Typical orders to go through this channel are: develop emergency plans to meet urgent demands, settle the dispute on working conditions overruling the standard practice, deplete the stocks in order to satisfy special demands, transfer manpower to another unit undergoing temporary crisis, etc. [29:91].

The actual mechanics of System Three will not be discussed at this point, but its complex interrelationships can be seen in Figure 4.

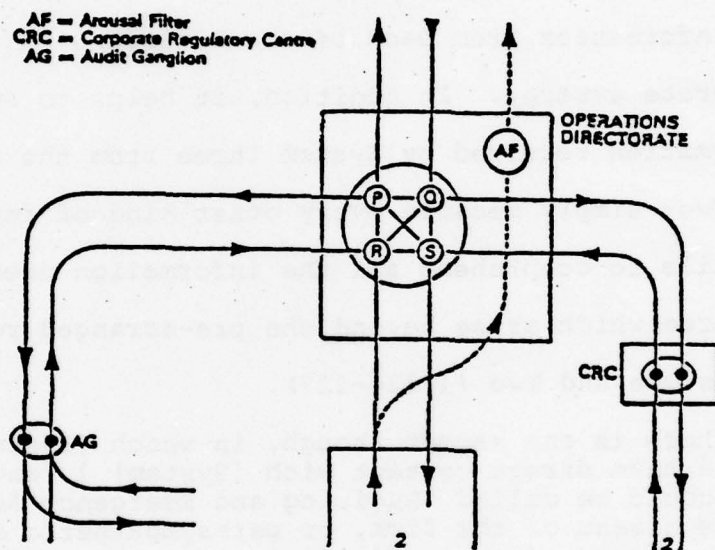


Fig. 4. Organization of Operations Directorate--
 System Three [4:226]

The position of System Three and its need to synergize the nature of performance indices with the corporate view of plans, policies, and strategies, places it in a situation of complexity. In this milieu it is ideally placed to use every kind of optimizing tool in its direction of current operations, from inventory theory to mathematical programming. A dynamic, current model of the firm's internal working must in fact emerge at this level, and it offers the ideal management tool for the control of internal stability (4:227-228). If full-scale scientific method is applied to SORO Division, it is System Three that is at the center of its major resource-allocation procedure. Linear programming techniques, or better still, dynamic programming techniques, belong at this level--and operate to this end (4:172).

System Three engages in complex resource allocation problems and needs the full range of mathematical techniques available to it; however, the resources are orchestrated in terms of the corporate policies and plans derived from System Four. So, it is to this system that this discussion now turns.

System Four--Development Directorate

System Four--Development Directorate is responsible for maintaining homeostasis with the external environment and the internal environment of the organization (4:185).

. . . the internal stability of the organism (organization) is ensured by the three lowest level systems-- a control apparatus summed up as far as this is concerned by the term autonomies³ [4:173].

System Four has a complex role which can be seen by reference to Figure 5. On one side it is directing information to System Five--Board Level, for the development of policies. On the other side it receives information from System Three about the internal environment. It is in the complex situation of correlating these two sources of its information, and in conjunction with information of the organization's external environment, it establishes corporate policy and plans. To achieve this, System Four requires adaptive models of the organization so that policies, strategies and plans can be projected into the future. Depending on the corporate external environment and its view of its performance and goals, a coherent set of policies and strategies can be advised to the lower levels.

From the position it occupies, System Four can choose to direct the activities of the systems below, or give assistance to them, or give assistance to System Five-- or even seek its assistance. In a sense, this flexibility is similar to the operation of a switch, and System Four acts like one. It exercises volitional control in

³Autonomic Management--those activities and functions which must occur within an organization without continuous higher level direction or supervision [4:172].

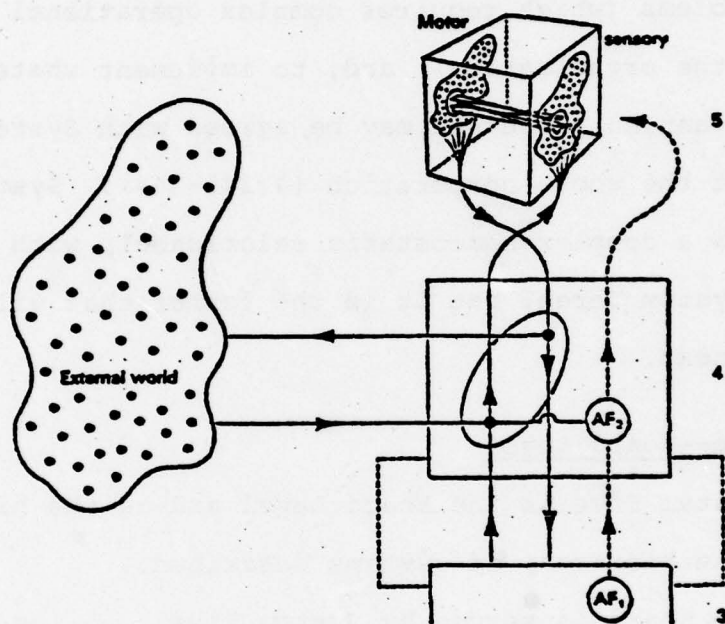


Fig. 5. Organization of Development Directorate--
System Four [4:231]

communicating between the autonomic level (Systems One and Two), and the corporate level (Systems Three, Four and Five).

To summarize: the Development Directorate exercises control of all those functions needed to: acquire information; to evaluate information and propose solutions to policy problems (which requires complex operational research models of the organization); and, to implement whatever adaptive planning processes may be agreed with System Five that affect the whole corporation (4:241-244). System Four establishes a complex homeostatic relationship with System Five and System Three, but it is the former that will be discussed next.

System Five--Board Level

System Five is the Board Level and is the highest level of the hierarchy of systems described.

The Board is served by System Five . . . as well as by its dependent Systems One to Four . . . for the Board must consider policies which are almost philosophies, or at least superior in some sense to the practical strategies considered by System Four. And System Four itself will assuredly pose problems upward to the Board--which it may inform but not usurp [5:43].

It receives information from System Four and System Three: the other corporate management systems, and passes appropriate instructions down the central command axis. System Five attempts at all times, with the service of System Four, to adjust its output to its latest input (4:232).

From the System Four view, System Five derives future goals for the corporate organization. The constant interaction between System Four, with its awareness of policy, performance of the organization, and its external environment, enables it to assess the future strategy options presented by System Five. System Five, then, has the purpose to foresee the future and develop viable strategies. System Four has the purpose to analyze these goals and strategies and test them against combinations of futures (5:43). To achieve this level of corporate development, System Five incorporates every feature of the organization in its environment which seems relevant to a consideration of the organization's long-term future. It must be capable of reflecting on the totally new departures in policy. Hence, the technique required by System Five is one of ultra-rapid simulation (5:43).

The corporate systems provide a clear representation of the relationship between managing the lower levels of an organization for achievement, and yet, still in harmony with its resources, policies and external environmental changes. The following quote further emphasizes that most traditional organizations have difficulty in recognizing the best mix and application of scientific methods.

Acting as the agent for operations research, econometrics, mathematical programming, or the like,

he [the scientific advocate] tends to see management as an instrumental function--as the application of Markov processes, Bayesian statistics, decision trees, or other technical artifices. But the fundamental problem is this: most of the instruments to which the students of management sciences are introduced--most of the technical tricks they are taught--are useful only in the face of the problems that emerge at the lower levels of modern enterprise [27:viii].

This is consistent with the presentation of System Three--that it is the system where all the scientific management techniques can be applied. It is the Board Level that does not lend itself to these techniques.

But they [the mathematical techniques] will not operate on the issues that emerge in the board room or the executive suites. The problems we find there simply do not, as a rule, lend themselves to the quantitative tools we have developed; they are too ill-structured, too broad in their ramifications, and too protean to be contained by the kind of mathematical models we are capable of constructing [27:vii].

At the Board Level, the members are identifying more with an industry as opposed to a company or enterprise. For SORO Division, the "Board Level" is interested in the organization's performance, but more in the sense of viewing the repair and overhaul operations and performance relative to support provided by all the other organizations, and not just simply in terms of SORO Division, alone. At a higher (Air Force) level, the System Five for that niveau, may be concerned about the combined defense capability of the armed forces. This is often referred to as "seeing the big picture." System Five, then, is the highest

system in the corporate structure, and for a particular niveau.

The Application Process

The methodology to be employed for this research study is based on complex concepts of cybernetics, operations research techniques, and other social science disciplines. The key principles have been presented and their relevance to this study has been connected to the management cybernetic paradigm. The question remains: how are all these synthesized and applied?

This question can be answered simply by likening the cognitive process to the skill associated with creativeness-- it is an art form, based on a complex understanding of many principles. While the creative style remains unique in art, it is not always true in science.

Science is the creation of concepts and their exploration in the facts. It has no other test of the concept than its empirical truth to fact. Truth is the drive at the centre of science; it must have the habit of truth, not as a dogma but as a process [11:77].

Consistent with this definition is the notion of science as the establishment of knowledge of the world, based on rigor (6:10). "Rigour is a precise formulation of method: something clear and definite, testable and repeatable [6:29]." Once the precise formulation of method is mastered, the results should be clear and definite, testable, and repeatable. In this sense, the art is in seeing

the proper place to apply the paradigm; while science, with its rigorous support, is represented by the paradigm itself.

The steps taken to apply the management cybernetic paradigm were as follows:

1. Identify the goals and objectives of the organization.
2. Identify the various functions and processes that link the organization to other corporate levels.
3. Establish, using the cone of resolution, that these functions can be homomorphically mapped through the successive hierarchical levels. And, in reverse, that the lowest level of abstraction can be linked to the highest level of abstraction. For example: Logistics to maintenance, and maintenance to logistics.
4. Identify the niveau of interest.
5. Relate the organization activities to the niveau being considered. Identify these as divisions of the organization. Note that the organization's activities may not be the same as the names currently in existence purporting to describe them. The key here, is to ensure that the grouped activities are consistent with the level of abstraction, and that the grouping is consistent with the higher level, and represents a system that can be recursed to another lower level of abstraction.

6. Using the concept of homeostasis, establish the homeostatic relationships between the grouping and managers relative to the total purpose of the organization. This represents System One.

7. Establish the homeostatic relationship between this group (division) and other related groups (divisions). This represents System Two.

8. Establish the homeostatic relationship between the grouping (Divisional Directorates) and the energy source (resources) of the organization. This represents System Three.

9. Establish the homeostatic relationship between the environment, policy, and organization energy source (resources). This represents System Four.

10. Establish the homeostatic relationship between the policy, environment and the limited energy available to the organization, and analyze, evaluate, and develop goals, objectives and long-term strategies consistent with these. This represents System Five.

These steps cannot replace the skillful use of knowledge. Hence, they represent, at best, broad guidelines to supplement other understandings of the cybernetic paradigm.

Development of the management cybernetic paradigm, as described in this chapter, provides a systematic way of representing and understanding an organization; and, for viewing the many diverse management theories and

philosophies that exist, in a realistic context. However, there is still an outstanding and important issue remaining for managers, and management theorists which is: How can all the cybernetic principles and the paradigm be synthesized for application to an existing organization? This is addressed in Chapter IV--Application, Analysis and Evaluation.

CHAPTER IV

APPLICATION, ANALYSIS, AND EVALUATION

Introduction

SORO Division fulfills an important support function: the depot level maintenance of RAAF technical equipment. In turn, its importance attracts concern about the effective management of its resources to meet operational commitments, and the collective performance of its managers. This concern was expressed in Chapter I--Introduction, where the problem for research was developed. In addition, it concluded with three research objectives and questions. It is the intention in this chapter to meet these research objectives, and to answer the research questions posed.

A direct application of the management cybernetic paradigm to SORO Division without an explanation of how it was achieved, would defeat the purpose of this research in two ways. First, the end result would not be understood, as it would appear magical. Second, the basis for any credibility would be lost.

To avoid these two difficulties, it is necessary to carefully develop the transition from the methodology to the conceptual application. Therefore, this chapter

addresses the application, analysis, and evaluation of cybernetics to the Royal Australian Air Force, Staff Officer Repair and Overhaul (SORO) Division of Headquarters Support Command. In particular, it describes the location of SORO Division with respect to the organization of the Royal Australian Air Force; provides a description of the SORO Division organization; presents the application of the management cybernetic paradigm; analyzes the application; and, evaluates the relevance of cybernetics to management.

SORO Division--Its Location and Description

In order to consider SORO Division in more detail later, it is necessary to gain an awareness of it as it currently exists. This will be quite detailed at times, but the description is intended as a basis for understanding SORO Division and the application of the management cybernetic paradigm. In fact, SORO Division can be substituted for another organization, if desired.

The intent of the following presentation is to provide a detailed description of the hierarchic structure linking the highest level of responsibility for Australian defense matters, to the specific organization that this study wishes to consider, analyze, and evaluate in more detail.

A simple overview will enable the detail to be held in perspective. First, there is a Minister for Defense accountable to the Australian Parliament. Second,

the Royal Australian Air Force, which has three levels-- Air Force Office, the highest level; Command, the middle level; and Base, the lowest level. Third, Headquarters Support Command is one of two commands, and has a sub-organization known as the Staff Officer Repair and Overhaul Division. This is the focal point of this study. Fourth, at the Base level, are located Operational Wings with their squadrons; Maintenance Wings with their maintenance squadrons; and Depot Level Maintenance facilities (which incorporates aircraft depots). This hierarchic relationship can best be visualized by referring to Figure 6.

The Australian National Defense Group Structure

The Australian National Defense Group of organizations are responsible to the Australian Parliament through a Minister for Defense. In turn, the Minister is responsible to the Parliament for the attainment of national military objectives through the three armed forces; Army, Navy and Air Force (3). The particular armed force of further interest is the Royal Australian Air Force, which will be shortened to Air Force, or RAAF.

The Royal Australian Air Force (RAAF)

The Royal Australian Air Force is, as are the other services, autonomous in the execution of its role. This is not without responsibility or accountability; for

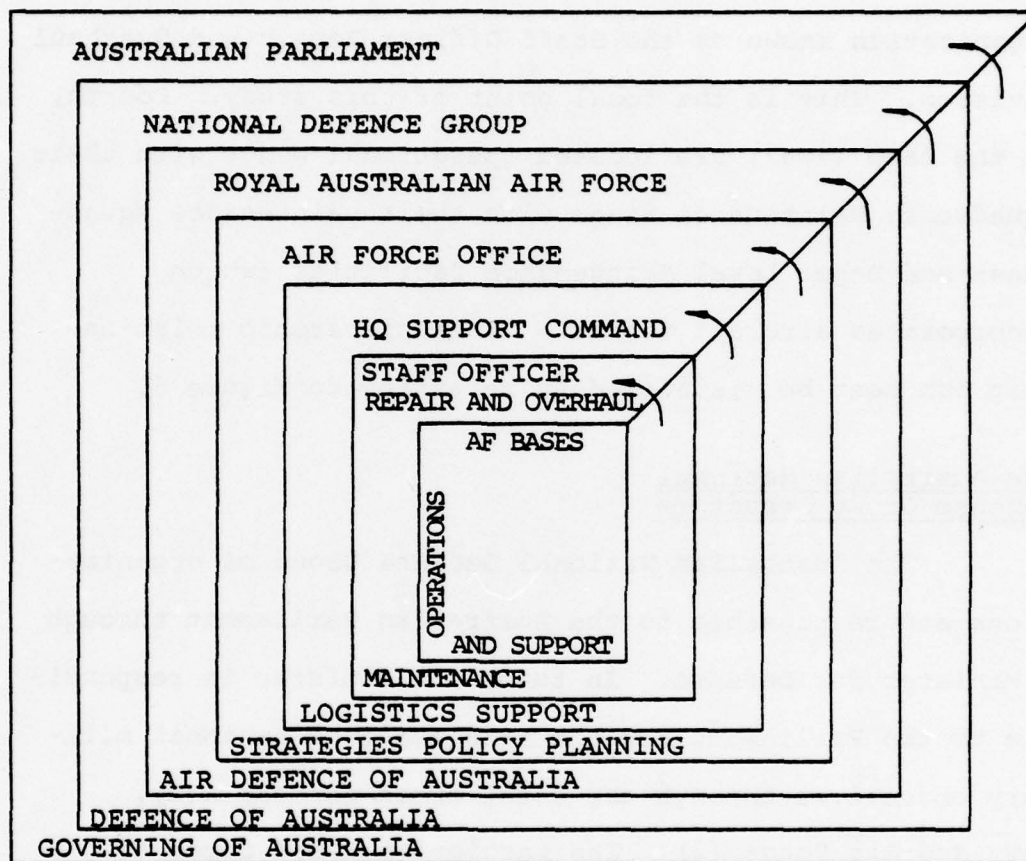


Fig. 6. Hierarchic Structure of Location--
SORO DIVISION

it is accountable to the Australian Parliament, through the Minister for Defense, Secretary of Defense, and the Chief of Defense Force Staff. There are three levels of the Air Force; namely, Air Force Office, Command, and Base.

Briefly, the Air Force office is the highest level of the RAAF and in a general sense fulfills a policy role. There are two Commands at the next lower level; Headquarters Support Command, and Headquarters Operational Command. The former will be addressed in more detail later as it contains the organization of interest for this research. At the lowest levels, the Air Force has a variety of bases within Australia. In addition, one base is located outside Australia. Headquarters Support Command has the responsibility to provide logistic support to these bases. Figure 7 presents a wire diagram of the generalized three-level organization structure of the RAAF.

Air Force Office

Air Force Office represents the highest organization level of the Royal Australian Air Force. It is responsible for meeting national military objectives, as related to the air defense of Australia, through the determination of policy and establishment of high-level objectives for the proper utilization of resources and conduct of air defense operations of the Air Force.

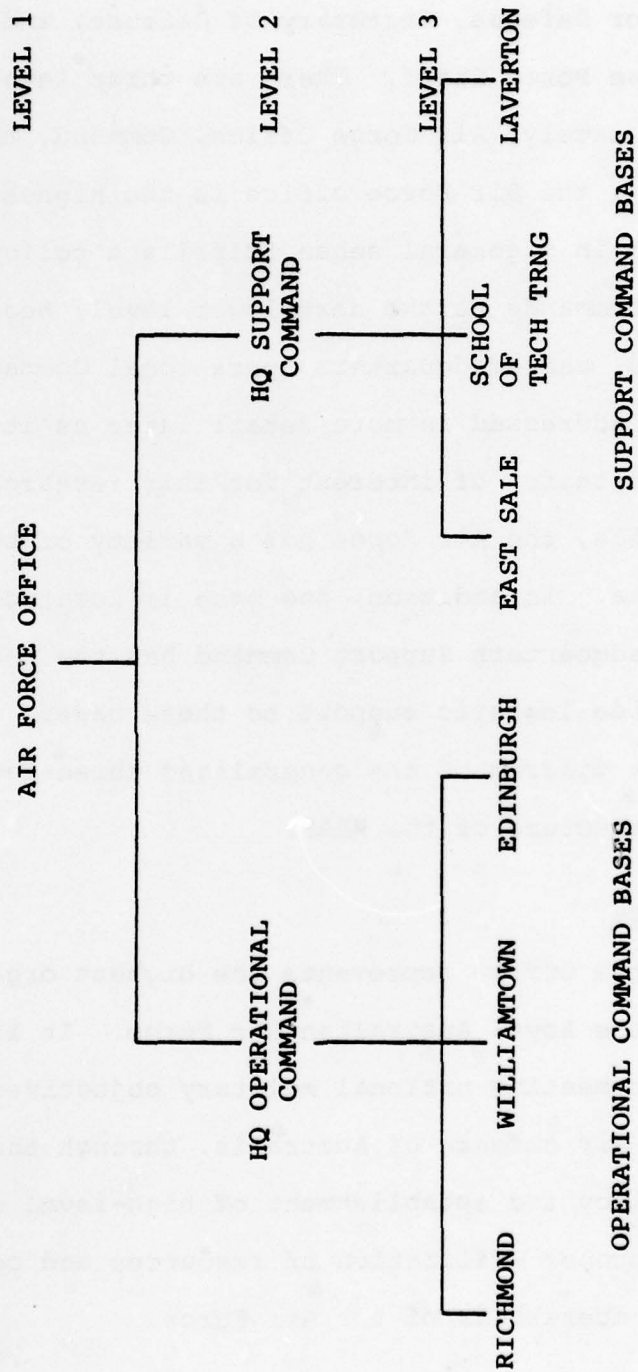


Fig. 7. Generalized Organization Levels of the Royal Australian Air Force

Headquarters Support Command

Headquarters Support Command has the role of providing a major part of the total logistic support required to meet the Air Force's operational commitments. It is autonomous, but is still responsible to the Chief of Air Staff, through the Air Officer Commanding (Support Command). It is in the middle level of the Air Force organization structure and exercises a coordinative role between the lowest level--Bases; and, the highest level--Air Force Office.

Support Command has an Air Officer Commanding (AOC) with five senior staff officers. One of which is the Senior Maintenance Officer (SMAINTSO). This appointment has the responsibility of four Divisions which will be mentioned throughout this research. They are: Staff Officer Repair and Overhaul (SORO) Division; Administrative Assistant Finance/Maintenance (AAFMAINT); Staff Officer Technical Spares Assessing (SOTSA); and Command Maintenance Officer (CMAINTO). The first Division (SORO), will be studied in terms of the management cybernetic paradigm discussed earlier. Figure 8 presents a wire diagram of the generalized outline of the Headquarters Support Command organization.

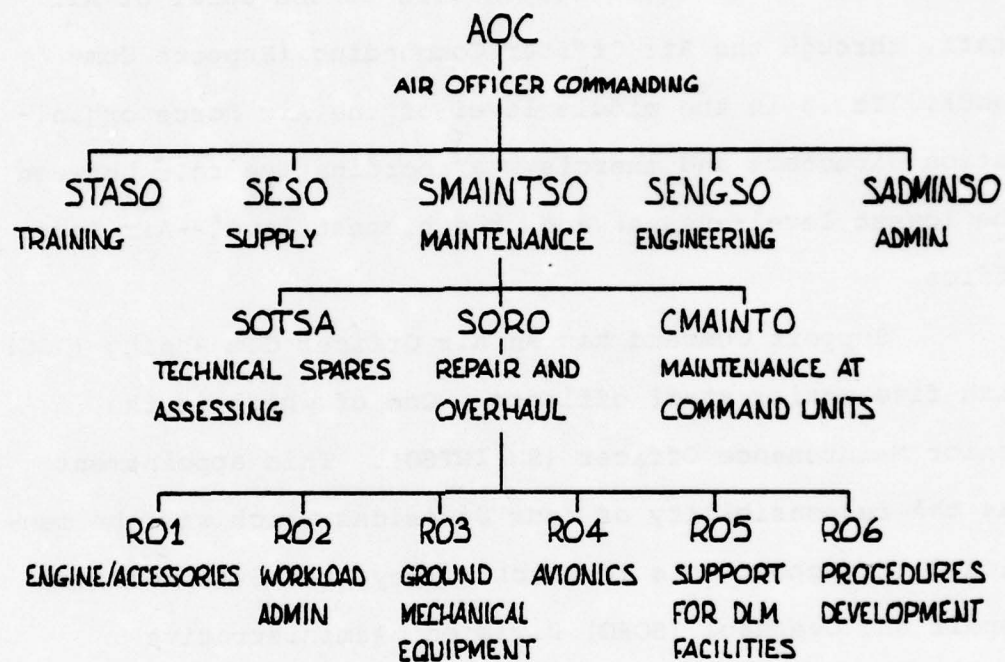


Fig. 8. Generalized Organization Structure for Headquarters Support Command

Base Level

The Base level is the lowest level of the Air Force organization. It includes operational wings and independent squadrons; maintenance wings; depot level maintenance facilities; and, independent support squadrons. These are not analyzed further; however, they are the end object of the functions and activities performed by Headquarters Support Command. For this reason, it is important to have an awareness that the Command is directing its support activities toward the operational requirements of the Air Force.

Summary of the Hierarchic Structure

The detailed analysis of the organization of the Royal Australian Air Force is important. It provides the hierarchic path from the top of the organization to the level of interest, which then leads to the suborganization of primary interest; namely, SORO Division.

Staff Officer Repair and Overhaul Division Existing Organization Description

The preceding development has provided a common knowledge of where SORO Division is relative to the Royal Australian Air Force, and why it is important. This section describes the broad functions and responsibilities of the organization.

SORO Division is responsible for the depot level maintenance of technical equipment to support the operational role of the Air Force. This echelon of maintenance has three paths: (1) maintenance performed by civilian organizations; (2) maintenance performed by organizations located outside Australia; and (3) maintenance performed in-house by air force personnel at nominated depot level facilities. These are titled Aircraft Depots, of which there are three; No 1 Aircraft Depot, No 2 Aircraft Depot, and No 3 Aircraft Depot. Each provides general maintenance support for the parent base, as well as having a specialized role--such as aircraft (airframe) inspection and maintenance, or engine overhaul.

Staff Officer Repair and Overhaul Division has the responsibility to manage the many different aspects associated with depot level maintenance. In addition, it is required to meet the needs of the Air Force Office, and other Support Command organizations. This is achieved by communicating performance information to the policy makers and those organizations that depend upon this information for strategic and tactical planning, or other purposes. So, SORO Division is required to meet the needs of an external environment, and its own internal environment. To understand the latter, it is necessary to take time to discuss it in more detail.

An Overview

SORO Division has six sections of responsibility:

1. RO1 Section--Engine and Accessory Maintenance.

This section is responsible for managing the depot level maintenance of aircraft engines, gas turbine compressors and other engine accessories.

2. RO2 Section--Maintenance Workload Administration. This section is responsible for the administrative coordination, compilation, distribution, and maintenance of the Annual Maintenance (workload) Program generated by the other sections and distributed to depot level maintenance facilities.

3. RO3 Section--Ground Mechanical Equipment Maintenance. This section is responsible for the management of depot level maintenance performed on mechanical transport, works plant, marine craft, air and ground telecommunication equipment, ground support equipment, electronic test equipment, and, the coordination of manufacturing requirements at RAAF Depots.

4. RO4 Section--Avionics Maintenance. This section is responsible for the management of depot level maintenance of avionics equipment categorized as Maintenance Supply Items (MSIs). This includes instrument, electrical, safety equipment, armament, airframe components, and coordination of overseas maintenance.

5. RO5 Section--Support Requirements for Depot Level Maintenance Facilities. This section is responsible for ensuring that depot level maintenance facilities have the resources to meet RAAF maintenance programs. Its interest is divided between managing the resources required to support a newly acquired weapon system, and the long-term on-going requirement for resources.

6. RO6 Section--Maintenance Procedures Development. This section is responsible for the management and development of procedures, coordination of the division's data processing requirements, staff training, and maintenance of technical publications (24:Sect.1,Ch.2).

Sections 1, 3, and 4 are involved in the actual management of equipment to the various depot level maintenance facilities. In turn, they are supported by the staff in Sections 2, 5, and 6. Each section is further delineated into subsections, usually denoted by an alphabetic character (e.g., RO4C). Figure 9 presents a wire diagram of the existing SORO Division organization.

SORO Division Functions

The functions of SORO Division can be described in terms of its goal: to support the operational needs of the Air Force through depot level maintenance of RAAF technical equipment (24:Sect.1,Ch.2). The word goal is used in the following sense:

```

graph TD
    Root --- R01[R01 ENGINE/ACCESSORIES]
    Root --- R02[R02 MAINTENANCE WORKLOAD ADMIN]
    Root --- R03[R03 GROUND MECHANICAL EQUIPMENT]
    Root --- R04[R04 AVIONICS]
    Root --- R05[R05 SUPPORT FOR DLM FACILITIES]
    Root --- R06[R06 PROCEDURES DEVELOPMENT]

    R01 --- 1A
    R01 --- 1B
    R01 --- 1C
    R01 --- 1D
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Fig. 9. Organization Diagram for Staff Officer Repair and Overhaul Division

. . . the goal-setting function is the highest level intellectual responsibility in the complex organization. It lends the organization its basic character, determining what fundamental mission will be served (e.g., what business it will be in, what service it will provide) and often defining the organization's ultimate destination (i.e., where its directors want it to go). The task of the goal-setters (or mission analysts) is thus to read the future, trying to identify those niches that the organization can hope to occupy with reasonable expectation of success. Thus, the goal-setter is the prophet of the organization, scanning the future for organizational opportunities, but at the same time being concerned that the organization seek its goals only within certain limits of behaviour. In short, it is in the goal-setting process that we decide what the organization should be, and in part, provide it with a certain code of conduct or, perhaps, a "personality" [27:68].

A detailed analysis of the functions to be performed aids identification of the activities, and the system that these, in combination, form. The essential functions in the current SORO Division organization are:

1. Formulation, computation, compilation and distribution of the Annual Maintenance Program (AMP). This latter program is an annual statement of expected, and authorized, workload for each of the depot level maintenance facilities. It also describes which equipments, how many, and where they will be maintained (2:Annex G). This process applies to a selected group of equipments that require depot level maintenance resources. The group covers a comprehensive range of airborne and non-airborne technical equipments that can be categorized as follows:

- a. Aircraft engines, gas turbine compressors and their associated repairable assemblies, subassemblies, and components.

b. Aircraft (airframe) systems and their associated repairables, assemblies, subassemblies, and components.

c. Airborne avionics equipments.

d. Non-airborne equipment known as ground support equipment, or aerospace ground equipment.

2. Support Services. These are, in a classic sense, the staff tasks of the organization. The staff positions provide administrative skills and technical knowledge that enable the line staff to fulfill their duties more effectively. For example, the compilation of the Annual Maintenance Program is achieved using a computer based system which is managed by RO2 Section (23).

3. Workload Management. Once the workload has been authorized by the Annual Maintenance Program each section monitors the arrival of equipment at the depot level facility. Through various procedures, involving computer outputs and manual charts, a manager monitors the workload and acts as a controller, or system regulator.

The essential focus of SORO Division's activities can be stated as:

1. The determination of the workload for each depot level facility.

2. The determination of the time taken to return an item removed-for-maintenance action to the user again.

3. The determination of the resources required to enable the maintenance actions to be performed.

Considerable rules and procedures have been developed around these key activities. In addition, they are further supported by administrative processes involving other external staff and a centralized computer system.

The relationship of these three focal activities is that a set quantity of equipments exist to meet the expected equipment maintenance turnaround time; each depot level maintenance facility is authorized to perform the determined workload; and, limited resources are apportioned to each facility. Hence, the desired workload is consistent with limited resources, maintenance policy, and the time required to service the equipment and return it to use.

The preceding description has been necessary to provide a common background. It also completes a general description of the functions of SORO Division, and its location with respect to the whole Air Force organization. It is now time to draw the relationship of the two descriptions--the management cybernetic paradigm and SORO Division--together.

Application of the Management
Cybernetic Paradigm

. . . in observing a little child, we find it is interested in everything and spontaneously apprehends, comprehends, and coordinates an ever-expanding inventory of experiences. Children are enthusiastic planetarium audiences. Nothing seems to be more prominent about human life than its wanting to understand all and put everything together [18:13].

A foremost requirement is that an organization be structured according to a consistency of purpose and function through all levels of its organization structure (14:3). For most organizations this has been ignored, and is evidenced by the degree of fragmentation that exists within its boundaries.

Of course, our failures are a consequence of many factors, but possibly one of the most important is the fact that society operates on the theory that specialization is the key to success, not realizing that specialization precludes comprehensive thinking. This means that the potentially-integratable-technico-economic advantages accruing to society from the myriad specializations are not comprehended integratively and therefore are not realized, or they are realized only in negative ways . . . [18:13].

Therefore, a first requirement is to observe the existing organization and establish its intended purpose, define its functions such that a linking thread runs from the top of the organization to the bottom. To do this the research team had to consider the meaning of logistics; mainly because SORO Division's goal is associated with maintenance--which is a subset of logistics.

. . . the logistics process is stratified into three general categories. First, strategic logistics is a function of national level requirements determination

and chiefly concerns the integration of logistics with strategy on one hand, and strategy with the national economy on the other. Second, support logistics is primarily concerned with the acquisition of material in the broad sense of design, development, procurement, and production. Third, operational logistics is involved with the sustained support of military operations in the field [21:124].

Within these strata, logistics is recognized as having the components of procurement, supply, transportation and maintenance, which work in concert (21:117-128).

Delineating the components of logistics is an attempt to make logistics--a highly abstract concept--more concrete (less abstract). In keeping with the notion of the cone of resolution, this can be described as moving down the cone. At this level of abstraction, maintenance is of further interest.

At the Air Force office of the Royal Australian Air Force (the highest organization level) interest in maintenance management is in terms of its performance relative to the whole logistic system; and, in a strategic sense, of developing logistic policies and plans consistent with limited resources. At Headquarters Support Command, logistics is further delineated into those functions (maintenance, supply engineering) and activities related to the support of operations. At an operational base, maintenance is part of providing the broad range of services and facilities for operations. These three relationships can be summed in the following way:

Military logistics is the process at the strategic level of determining the force structure; at the support level of translating the broad statement of requirements into useable military assets; and at the operational level of distributing and applying the assets as well as providing the broad range of services and facilities necessary for the movement and sustained support of combat forces [28:119-120].

In this way the notion of logistics is consistently mapped from the top to the bottom of the organization such that there are understood relationships within the levels, and in the connecting interfaces. Note that at the highest level, logistics has an almost alien meaning to that understood by the lowest level--the operational base. The notion of recursiveness, homomorphism, and the cone of resolution enables this difference to be accepted without creating a discontinuity in the relationship between the two. Furthermore, it reveals the cause of many communication problems that exist between top management and the bottom levels, which is: that they are both "speaking" a different language. It should not come as a surprise that they are; nonetheless, it does. It is the principle of recursion and autonomy that bind the respective levels (9:7). These two concepts are not always clearly understood. Hence, the connecting interface between the different levels becomes a source of conflict and communication breakdown.

The purpose of the preceding description has been to show that at the highest level of the RAAF managers are

concerned with the joint coordination of operations and support. In terms of the management cybernetic paradigm, these two functions represent two Divisions (Operations and Support) that form part of System One. These could be used as the basis for further analysis of the Air Force Office; however, it is outside the scope of this research: the organization of interest is SORO Division, within Headquarters Support Command. Refer to Figure 10, Generalized RAAF Niveaus.

The principle of recursion leads to the next step, which is to further delineate support into the elements of procurement, supply, transportation and maintenance (21: 117-128). The organization of maintenance is considered in more detail.

Maintenance is split into three echelons; operating, intermediate, and depot levels. The first two levels are under the control of Headquarters Operational Command, while the latter is the responsibility of Headquarters Support Command. Justification for the division of responsibility between the two Commands is curious, but outside the scope of this research to examine and explain.

At Headquarters Support Command, there is a Maintenance Branch with four divisions; Staff Officer Repair and Overhaul (SORO), Staff Officer Technical Spares Assessing (SOTSA), Administrative Assistant Finance/Maintenance (AAFMAINT), and Command Maintenance (COMMAINT). In terms

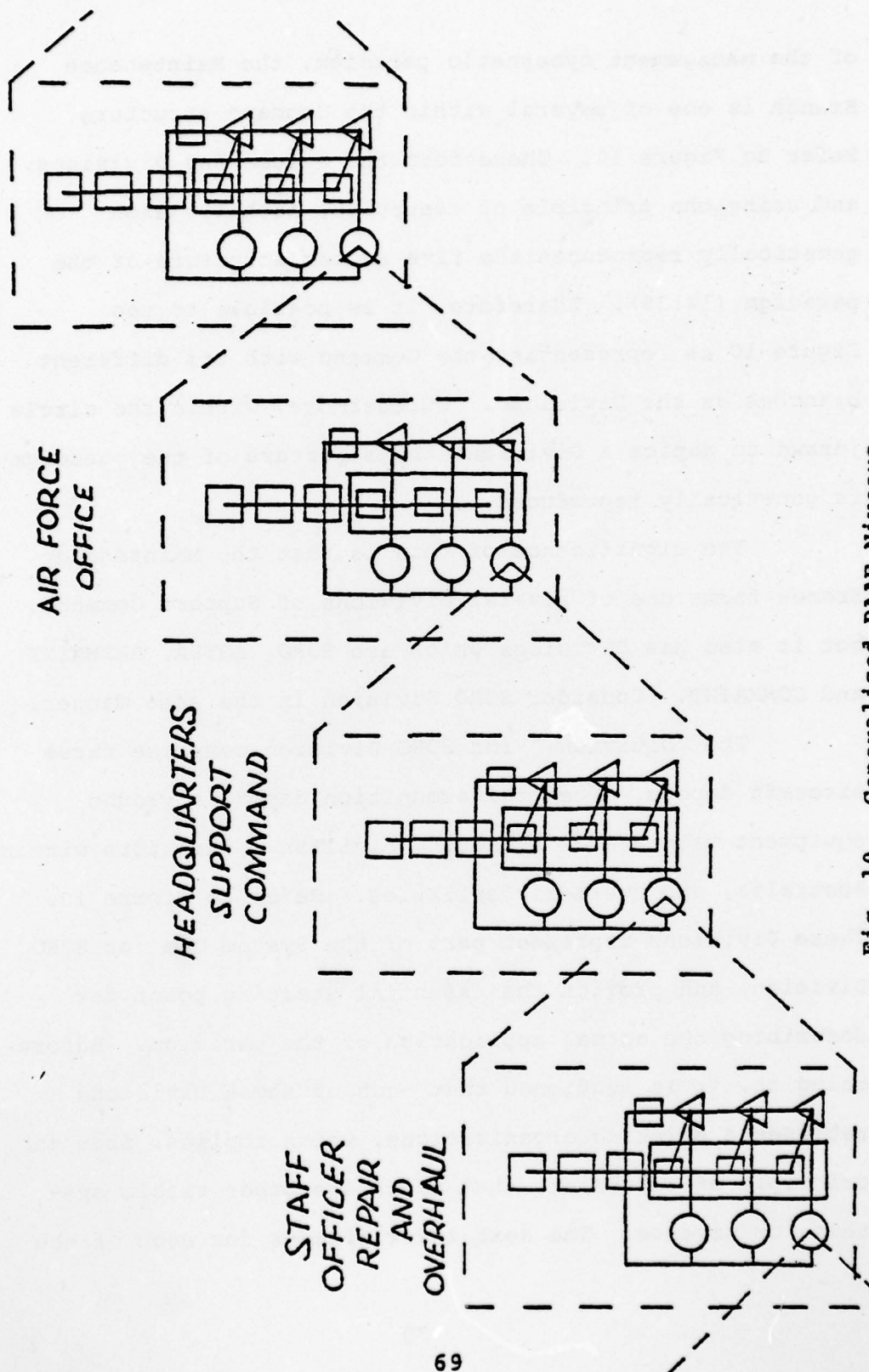


Fig. 10. Generalized RAAF Niveaus

of the management cybernetic paradigm, the Maintenance Branch is one of several within the Command structure. Refer to Figure 10. These form the System One Divisions, and using the principle of recursion, each Division genetically reproduces the five system structure of the paradigm (14:25). Therefore, it is possible to see Figure 10 as representing the Command with its different branches as the Divisions. Furthermore, within the circle (drawn to depict a Division) the structure of the paradigm is genetically reproduced.

The significance of this is that the Maintenance Branch forms one of several Divisions of Support Command, but it also has Divisions which are SORO, SOTSA, AAFMAINT and COMMAINT. Consider SORO Division in the same manner.

The "Divisions" for SORO Division comprise three aircraft depots, a central ammunition depot, a ground equipment maintenance squadron, civilian contractors within Australia, and overseas facilities. Refer to Figure 10. These Divisions represent part of the System One for SORO Division, and provide the essential starting point for describing the actual application of the paradigm. Before doing so, it is mentioned that each of these Divisions represents existing organizations, which implies, from the principle of recursion, that there are other viable systems, or niveaus. The next lower niveaus for each of the

aircraft depots could be developed except that it is outside the scope of this study.

Each of the aircraft depots and contractor facilities represents an autonomous organization that can be viewed as part of SORO Division's external environment for its System One Divisions. Refer to Figure 10. From a control viewpoint, the external environment is that which the controller interacts with, but of which the workings are not equivocally discernible, even in principle, and which cannot be directly changed, only influenced. For example; a firm (the controller) hopes to influence the market by setting the prices, launching new products, and in many other ways. The market responds by demanding the firm's products, demanding those of a competitor, or not demanding this product-type at all, depending on what the firm and its competitors have done. The important distinction is that, while it can be said with certainty how the controller reacts to the environment, the same cannot be said for the environment's response to the controller (16:25). For SORO Division this means that it can perform functions that relate to contractors, but it is unable to appreciably change the relationship that exists between them and itself. Figure 11, A System Controller, Environment and Complement, illustrates this relationship between the controllers, environment and complement.

SYSTEM BOUNDARY

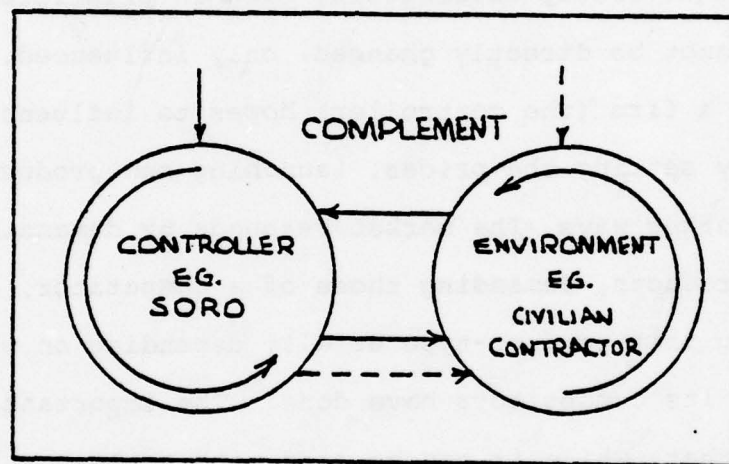


Fig. 11. A System Controller, Environment and Complement [16:26]

Description of the Management Cybernetic Paradigm for SORO Division

The development in the preceding section represents a critical process--identification of the operating divisions and location of the focal niveau. The System One divisions, as described, provide the basic starting point for the development of the paradigm.

System One--Operational Unit

The System One divisions incorporate the SORO Division sections responsible for Engine (RO1), Ground Mechanical Equipment (RO3), and Avionics (RO4) Maintenance. These three sections determine the workload of each of the depot level facilities, monitor the progress of this work through the facilities, and manage the work to each facility. Each section performs these tasks in terms of the equipment/trade relationship. For example, engines and their accessories are managed by personnel with an engine trade training background. The work is not managed in terms of the depot level maintenance facility. That is, regardless of the equipment's parent (engine, airframe, avionic) the equipment is not directed to a common aircraft depot manager.

The distinction between the two approaches is related to the concept of specialization discussed earlier. The trade specialization fragments the management task into parts that are inconsistent with the organization's ability

to maintain effective control. The alternative, managing the work in terms of the facility, tends to specialize, but in a way that supports the goal of SORO Division. Furthermore, it is consistent with the cybernetic principle of recursion.

In the previous chapter, System One was described in detail. Most of the detail concerned the nomination of variables that could be monitored by the use of statistical analyses to produce a set of indices; actuality, capability and potentiality. These were described as the basis for a performance measurement system.

The quantitative measurement of critical variables associated with activities performed by each Division is of utmost importance. For this reason, considerable care is required to determine and select the critical variables to be measured and monitored. Furthermore, the importance of this feature of the paradigm warrants a more detailed account. Before proceeding, time ought to be taken to study Figure 3, Organization of Divisional Management--System One.

The process of identifying the critical variables is a task for an operational research team in conjunction with each Division of the paradigm. Such a team performed such a task in Chile while attempting to install a regulatory system for the social economy (9:6).

The further task of the operational research teams was to identify a preliminary set of critical variables in each system under study. For example: we needed to identify the size of stocks, input, output, and inter-process; we needed to identify bottleneck operations; in all cases we identified the level of absenteeism as a critical variable, since there is at least some evidence that this is a measure of social unease [9:8].

For SORO Division, the critical variables would need to be determined on-site, and in conjunction with the managers involved. However, a preliminary assessment indicates the following variables: manhours of work authorized for each depot level facility; maintenance time; time between arrivals of equipment at a facility; production time targets; resources consumption/requirements. There are possibly many others, but they can only be determined through a knowledge of the operations involved; discussion with the operators; and, the perception of a disciplined mind.

Assume that the variables have been identified, and the organization is providing live data each day. Traditional management usually requires that computer programs be written and a management information system be developed. In cybernetics, the next step is to reduce the variety being generated--not to amplify it.

The answer is to reduce every input datum to a triple index, in which all numbers range simply between 0 and 1. When the operational research teams touring the plants [Chilean industry] had made their models and identified the critical variables, they were asked to agree on two values, relating to each variable, with the management. The first value was capability. This means: how should this variable perform under existing conditions, when the whole system is running in the

smoothest way we have ever experienced or can envisage? The second value to be agreed for each critical variable was potentiality. This stands for a better performance than capability, based on the realization that if only we had one more machine in a bottleneck section; if only we had a better lubricant; if only we could install a conveyor belt; and so on, then we could do this much better [9:9-10].

The values for capability and potentiality seldom change. They can be stored in a computer, and their ratio provides an index called latency: the latent performance that could be released by new investment. The daily data is a measure called actuality, and the ratio between actuality and capability yields the classic index of productivity, while the ratio between actuality and potentiality yields an overall performance index. Performance can also be computed by multiplying together the indices for latency and productivity (9:10). These indices and their relationship can be better visualized by reference to Figure 12-- Three Measures of Capacity and Three Measures of Achievement.

The significance of these indices is that they can be used to determine whether changes in them are of importance. Briefly, actuality data arrives and is examined for plausibility. This is done by statistical tests to ensure that the data belongs to the population of which it is supposedly a sample. When the datum has been accepted, the capability and potentiality associated with this variable are drawn from computer memory, and the three indices are computed.

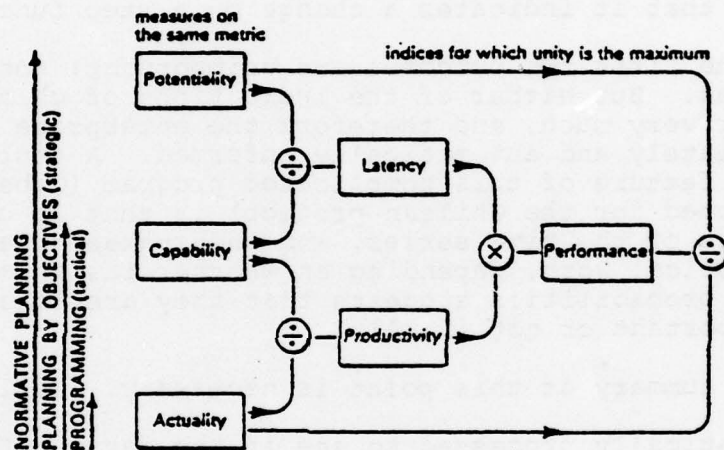


Fig. 12. Three Measures of Capacity and Three Measures of Achievement [4:209]

Now this [index] value is the latest in a time series of the values that have been computed for this variable day by day. The question that the program must now answer is: does this new result matter at all, or is it to be understood as a chance variation in the ordinary course of events [9:11]?

The answer to the question rests on Bayesian probability theory. For each new point computed, four probabilities are computed: that it is a chance variation in the time series; that it is a transient; that it indicates a change of slope; that it indicates a change by a step function.

The first two outcomes are unimportant: nothing happens. But either of the indications of change matter very much, and therefore the enterprise is immediately and automatically informed. A truly cybernetic feature of this complicated program [Cyberstride--developed for the Chilean project] is that it uses more or less of the time series, and undertakes more or less statistical work, depending on whether its assessment of these probabilities suggests that they are likely to be important or not [9:11].

A summary at this point is necessary. Daily data are statistically processed to see if the datum reflects any significant movement from desired values. In essence, these data are produced by the Operational Units and passed to the Divisional Regulatory Center where statistical filtering occurs, and achievement indices are formed. Any changes to the indices are passed to the Divisional Directorate for reconciliation with strategic plans, and tactical programs, or for initiating special action to other Divisional Directorates in the Command axis (the vertical central axis of the paradigm) (refer to Figure 2) (4:215-218). This is all taking place at one niveau (SORO Division).

Values of the indices will only be transmitted to another higher niveau--if the lower niveau cannot resolve the problem in terms of its own resources. In this way, urgent information can be transmitted (communicated) from the lowest to the highest levels of the organization--and in reverse. All without disrupting the other activities taking place, and in an almost matter-of-fact way (9:14).

System One--Relevance

The relevance of System One to SORO Division is as follows:

1. The divisions described for the paradigm represent a new way of arranging and seeing the SORO functions.
2. The variables described are not the only variables--there are others, and they need to be derived by a competent operational research team in conjunction with the managers involved.
3. A capability does not exist for processing the variables, and deriving the indices described.
4. The Divisional Regulatory Center provides a consistent means of communicating information to the operational unit from System Three--Operations Directorate, and reverse.
5. The Divisional Regulatory Center also provides a formal means of communicating the performance of each Division to the others.

6. SORO Division is currently organized with servicemen, along trade categories, or musterings--such as Electrical, Airframe, Engine, etc. This may have to be tempered to apply the superior organization concept described, and in order to realize improved utilization of limited manpower.

7. Since each Division is dealing with a variety of equipments going to any one facility, a natural need to communicate arises. This need is met by the Divisional Regulatory Centers and Divisional Directorates.

8. SORO Division will not be required to undergo a large reorganization, simply because existing staff, concerned with the particular Divisions, need only provide data concerning the identified variables. It may prove prudent, in the long term, to evolve towards the description posed--although this may change by the need for the organization to remain viable and adaptive to future, unforeseen, environmental changes.

9. SORO Division has access to the Melbourne, Regional Computer Center (MRCC) and an in-house Hewlett-Packard micro-processor; however, the development of the programs to analyze the indices using Bayesian statistics is the responsibility of a competent operational research team.

10. The important task of developing strategic plans and tactical programming occurs within the System One--

Divisional Directorate. These are constantly updated and changed on the basis of information received from the Operational Unit--and the other Divisions. This important task needs to be performed by an experienced manager who can develop the strategic plans and tactical programs for the Operational Unit, and understand what needs to be done when a change occurs or a message is received from System Three. (Remember: System One is on the command, vertical axis.)

System Two--Integral Control

System Two--Integral Control, was discussed in detail in Chapter III--Methodology. The important points to be made from that presentation are:

1. That the System Two links all the Divisional Regulatory Centers to the Corporate Regulatory Center.
2. That the performance of each Division is communicated to the other Divisions.
3. That the communicated performance is in terms of the indices previously described.
4. That the Corporate Regulatory Center adopts the corporate view and synthesizes each Division's performance with the other Divisions. The collective value of the System One performance is communicated to System Three where the Division's operations can be further assessed.

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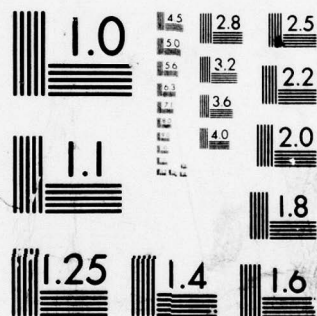
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In essence, System Two is ensuring that the Divisions are performing according to the strategic plan and tactical programs developed. Remember, that these plans and programs are in terms of the indices.

. . . the mechanics of System Two are found in the interlinking of the Divisional Regulatory Centres, and in the Corporate Regulatory Centre. . . . So it would be correct, and even helpful to think of System Two as an elaborate interface between Systems One and Three [4:220].

Figure 13, Organization of Divisional and Corporate Regulatory Centers--System Two, illustrates how the Divisional Regulatory Centers are interconnected.

The importance of System Two is that it gathers the filtered data, in the form of the indices from each regulatory center, to form a corporate view of performance. This corporate view is formed for use by System Three. System Two acts to regulate competitive behavior of the Divisions which, if left unregulated, would deteriorate into dysfunctional behavior in the form of political maneuvering for scarce resources, or basic mistrust of the others.

System Two also stabilizes the interaction between the divisions. Remember that the indices formed for one division are communicated to each of the other divisions. Without the Corporate Regulatory Center, each division would interpret the indices in its own terms of production, resource dependency, and events that may not be relevant.

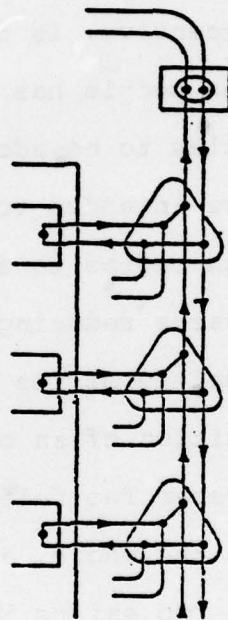


Fig. 13. Organization of Divisional and Corporate Regulatory Centers--System Two [4:221]

The end effect will be, as is currently seen in SORO Division (which does not have a sound System Two), that each section reacts to the other, which causes the next section to over-react. Soon the sections are ". . . in a competitive situation instead of a collaborative one, and experience shows that this is where communication breaks down [4:222]." It is worth noting that the competition for resources, while the incentive, is not the real culprit. It is that trust between people has been lost. In turn, this causes informal rules to be adopted at the section/division level which are intended to secure local satisfaction--and oscillation begins to set in (4:222). SORO Division has tended towards reducing these dysfunctional effects--more by the quality of its recent managers than by the existence or recognition of an operative System Two.

Nonetheless, System Two fulfills an important link, which is vital to the whole, and ought not to be left to chance. System Two exists in SORO Division in an informal, almost unrecognizable way. It is in the prevailing sense of goodwill, cooperation and common sense exerted by each of the Section Heads and their staff, and their awareness of a common goal. This is admirable, but if the importance of their identification with SORO Division's goal, and their mutual cooperation is not recognized as the important thing it is, it could easily be destroyed by an untrusting, poorly dedicated manager--or worse still,

leader. One may describe this relationship in a number of different words, that each say almost the same thing: esprit de corp, goodwill, morale, psyche, and eudemony. This latter word refers to the collective social feeling of a group.

And I have noticed that people, though uneducated, though inarticulate in an intellectual context, are well able to express themselves in terms of their happiness or unhappiness with a given state of affairs. For this kind of social happiness, which is quite different from inward spiritual joy, I use Aristotle's word, eudemony [9:21].

The point is that when an atmosphere of goodwill, or well being, and trust endures among people, a spirit of cooperation exists which is capable of displacing and replacing dysfunctional behavior.

System Two--Relevance

The relevance of System Two--Divisional Directorate to SORO Division is as follows:

1. An informal System Two exists in the form of a spirit of cooperation, but this is inadequate as a basis for developing a longer lasting and scientifically based performance system.

2. The existing informal system does not link the performance of one section to the others. Therefore, a System Two with interconnected Divisional Regulatory Centers is required.

3. In the current SORO Division organization, System Two is a collective or pervasive feeling; however, in terms of the function to be performed, RO2--Maintenance Workload Administration, acts like a System Two. The RO2 Section tends to coordinate the efforts of RO1 (Engines), RO3 (Ground Mechanical Equipment), and RO4 (Avionics) Sections. This is achieved through the role of the Annual Maintenance (workload) Program--which is coordinated by the RO2 Section.

4. Recognition that RO2 Section fulfills this important role (in part, and often in conflict with the other Sections) means that the section needs additional staff to match the variety of the input sources to the section (Ashby's Law of Requisite Variety).

5. The task fulfilled by the RO2 Section needs to be more in terms of maintaining the corporate performance, without the "policeman" overtones that often arise.

6. The task of the Corporate Regulatory Center is to synthesize the performance of each Division, and pass information to System Three on the corporate command axis. Hence, a new style RO2 Section needs to recognize and meet this requirement.

7. The Corporate Regulatory Center function of synthesizing the indices from each of the Divisions requires the use of a computer. The computer at the

Melbourne Regional Computer Center is capable of meeting SORO Division's need.

8. A reorganization of RO2 Section is essential. For the short term, it could continue the way it is except that the additional planning function will need to be added. In addition, it will need information of each Division's performance to use as a planning basis, and an awareness of the corporate policies and strategies.

The most difficult features of System One and Two are:

1. The determination of the variables to monitor.
2. The development of the statistical and computer package to process the variable values for the indices.

These are not particularly difficult problems to overcome. In both instances the technology exists, and is available. If anything, the difficulty is in obtaining the skilled statistician and programmers to understand the requirement. This is not insurmountable, but it will take time to develop the system. In light of these thoughts it is worthwhile to quote how the development of the social economy of Chile progressed:

During its life of approximately 18 months, the project advanced much more than the most optimistic original forecast. This possibility of very fast progress, seems intrinsic in the basic approach of CYBERSYN which links research, development, planning and execution in a unique process in which every activity is merely one aspect of the dynamics of the

system and there is a steady feedback from each activity to every other one. Fast progress was reflected in many facts, the main ones being: definition of the configuration of the system and effective operation contact of the group of experts with most of the units of the system within the period of one year; development of the whole scheme of information flow required for decision with appropriate computer programs for its analysis, filtration and integration for different levels of decision making; implementation of such programs and establishment of the routine flows of information; substantial progress in the development of programs for long range planning and simulation; ample discussion of the project at all levels of the system and programs for training of high and medium range executives and workers [26:79].

Some may balk at the thought of developing a cybernetic system for a national economy, let alone accept that these comments can be made after an eighteen-month period. In comparison, this application of management cybernetics to SORO Division seems minor.

System Three--Operations Directorate

System Three--Operations Directorate is the first system in the corporate command axis (vertical) of the management cybernetic paradigm. Its function is to govern the stability of the internal environment of the organization, and to adopt the corporate view (4:224). This system fulfills a complex role which was discussed in Chapter III--Methodology; however, recall that it is the center for resource-allocation, or management of the organization's resources.

In this context, the RO5--Support Requirements Section fulfills, in part, the concern for resources and

their allocation to each of the depot level maintenance facilities. The Support Requirements Section is conscious of the money available to purchase equipment--even if it is unable to control its source. Note that this section does not see itself as regulating the internal stability of Systems One and Two (RO1, RO3 and RO4 Sections) already discussed; however, it tends to coordinate its activities in terms of the resources available to, and requested by, these other sections.

A critical aspect of resources management of an organization is that there is always less than is required. This usually causes competition, which often degenerates into dysfunctional behavior. In cybernetic terms: the internal environment becomes unstable. It is the function of System Three to ensure that the System One Divisions do not become unstable.

System Three receives performance information from the Corporate Regulatory Center, and has access to each of the Divisions through its Audit Ganglion. Furthermore, it can pass the latest policy, and strategy plans to the System One--Divisional Directorates for their incorporation.

The management of SORO Division's resources is vital. The current task performed by the existing RO5 Section should be absorbed as part of the Division's function. The function of resources management for SORO Division is almost nonexistent; but, is performed, by default, by other

staff external to SORO Division. For example; AAFMAINT controls the authorization of funds and the accounting of equipment to civilian contractors. Other Headquarters Support Command organizations control personnel; and, funds for the purchase of test equipment for the depot level maintenance facilities.

This type and level of management, and the need to adopt a corporate view, places System Three personnel in an area of considerable complexity. The complexity is not only related to the technology, but the mathematical techniques that are required to be used. In addition, the personnel working in this area need to understand the nature of the corporate view, and the relevance of the individual Divisions to the whole of SORO Division. Personnel that meet these criteria do not "appear," they must be educated in one of the disciplines of higher learning, and be groomed from within SORO Division.

This latter point is worthy of a small digression. In an earlier discussion emphasis was given to the different understandings that would develop over the concept, "logistics," between the top and bottom levels of the organization. It was explained that the difference could be attributed to both levels "speaking" a different language. In effect, this same difference applies to the above situation. It takes time and experience to gain an understanding of the language used at the different system levels. Hence,

the emphasis that the higher system staff in the corporate command axis need to emerge from the lower level systems.

The language in use at System Three is related to the corporate nature of SORO Division. In addition, there must be an awareness of SORO Division, in the sense that comprehensive models must exist which provide the basis for taking decisions.

Decision, then, is an event detectable, describable and indeed determinable, by the parameters and states of a model--whether this be formulated rigorously by the scientist, or unconsciously by the manager [6:211].

The relevance of this last statement is that the models in use at System Three can be conceptual models within the minds of the managers, or, quantitative or mathematical models that are dynamic in nature (Markov Analysis).

This System Three is ideally placed to use every kind of optimizing tool in its direction of current operations, from inventory theory to mathematical programming. A dynamic, current model of SORO Division's internal workings must emerge at this level (4:227-228).

System Three--Relevance

The relevance of System Three--Operations Directorate to SORO Division is as follows:

1. An effective resources management capability does not exist within SORO Division.
2. SORO Division will require an investment of qualified personnel to be employed in the described

System Three. These will range from experienced managers to graduates from higher education institutions.

3. System Three requires a set of working models. These may employ a range of mathematical techniques such as; inventory models, linear programming, and Markov Analysis.

4. System Three communicates upward, downward and "sideways" (laterally). Therefore, it must have an ability to communicate in these directions, as well as receive communications from them.

5. An important feature of System Three is the Arousal Filter for transmitting urgent messages "up" the command (vertical) axis. For SORO Division this means that an Arousal Filter must exist for rapid communication with the higher systems (Four and Five).

This research is not intended to impose mathematical techniques or models on SORO Division. Its intention is to show the context in which such techniques can be applied. The decision to use a known technique must be based on the need for it.

This latter point stresses that the management of SORO Division must recognize and accept that a need exists, and be prepared to adopt the solution. In the context of this research study, the final solution to be adopted should be that proposed by an interdisciplinary operational

research team who have developed their solution by working with SORO Division managers.

So it is important for management to accept the advice of operational research people themselves, that OR teams should indeed be interdisciplinary in character. This point is underlined because there is a strong tendency in industry today to accept for OR work only the kind of scientist that one would expect to meet within the industry anyway. In metallurgical industries, management is accustomed by now to meeting engineers, physicists, chemists and metallurgists. They are puzzled by the arrival in OR teams of biologists and sociologists, for example. But these are the very people who will be of most use in solving managerial problems of tactics and strategy. They are neither stereotyped nor committed in advance to a point of view [6:50].

It is worth noting that many in-house style management studies have great difficulty in maintaining an objective approach to the problem at hand. In fact, the following reports have resulted from such studies: Presentation on Management Requirements for the Preparation of Engineering and Maintenance Management EDP Specifications, 24-25 May 1976 (13); and, Management Systems Study Group Final Report, 30 September 1977 (2). The writer was a team member of both studies. The point to be made is that each member of such study teams came from a defense force with engineering backgrounds and some fixed perceptions of the problems and their solution, yet without an awareness of the corporate view. The referenced reports have increased an awareness of problem areas; but, have not been able to enhance or advance the implementation of a solution.

System Four--Development Directorate

System Four--Development Directorate has the task of maintaining SORO Division stable relative to the external and internal environment. Refer to Figure 5. It fulfills a number of key functions which are:

1. To pass information about the environment to System Five--Board Level.
2. To pass information about the environment to System Three--Operations Directorate.
3. To continue the Arousal Filter link from System Three through System Four to System Five.
4. To receive goal and policy intentions from System Five and test their feasibility, affects, and implementation requirements.
5. To communicate policy to System Three for the development or change of operations, and the control of resources to meet the policy intent.

To a point, RO6--Maintenance Procedures Development meets the System Four role. In its position, it is aware of the difficulties being experienced by the internal members of SORO Division. It is also aware that the internal instability is influenced by the external environment, and the policies emanating from the office of the Staff Officer Repair and Overhaul (SORO).

In terms of the management cybernetic paradigm, RO6 Section as System Four, needs to be recognized as a

corporate system existing on the command (vertical axis). Its intent is to test the feasibility of goals and policy, and not to usurp the role of System Five: "And System Four itself will assuredly pose problems upward to the Board . . . which it may inform, but not usurp [5:43]." The communication link between Systems Four and Five is important. Without an awareness of the external environment, System Five will produce goals and policies that are inconsistent with the real world, or have a detrimental short- or long-term effect. It is the role of System Four to keep System Five aware of the real world environment, and assess the effects of the policies developed by System Five.

To fulfill its role, System Four requires; a comprehensive knowledge of SORO Division and its activities; effective models of the organization and its systems; dynamic simulation techniques; and techniques that enable the external environment to be evaluated, or incorporated into the organization models. In some ways the task of assessing the environment is in the minds of most managers who are aware of the change in societal values. The problem for System Four is to structure a way to incorporate these changing values into the models used for evaluating System Five goals, policies and strategies.

System Four--Relevance

The relevance of System Four--Development Directorate to SORO Division is as follows:

1. A simplified version of System Four exists in the form of RO6--Maintenance Procedures Development.
2. The role of System Four, to evaluate goals and policies, is an important corporate function. In the existing structure there are few policies evaluated for their long-term effects.
3. In relation to the evaluation of policies, the existing RO6 Section does not have the capability. Assessment of policy is usually based on judgement, and adverse feedback.
4. SORO Division needs to be aware--not only of the social environment, but that which relates it to other organizations. For example; supply and engineering staff of Headquarters Support Command form an important part of SORO Division's external environment.

System Five--Board Level

System Five--Board Level accepts the final responsibility for the survival of the organization--SORO Division. It is the highest corporate system and accepts the responsibility for the establishing of corporate goals, its performance, its future, and its ability to survive in the long term. In terms of establishing goals:

. . . the goal setting function is the highest-level intellectual responsibility in the complex organization. It lends the organization its basic character, determining what fundamental mission will be served (e.g., what business it will be in, what service it will provide) and often defining the organization's ultimate destination (i.e., where its directors want it to go). The task of goal-setters (or mission analysts) is thus to read the future, trying to identify those niches that the organization can hope to occupy with reasonable expectation of success. Thus, the goal-setter is the prophet of the organization, scanning the future for organizational opportunities, but at the same time being concerned that the organization seeks its goals only within certain limits of behaviour. In short, it is in the goal-setting process that we decide what the organization should be and in part provide it with a certain code of conduct or, perhaps, a "personality" [27:6-8].

This quote provides several issues for discussion concerning System 5. First, there is a definite emphasis on the importance of the corporate goal-setters and the impact that goals have on the organization. This point is equally applicable to SORO Division, as it is to all organizations. Second, it clearly identifies goal-setting as a high-level intellectual responsibility. This is consistent with System Five as the highest corporate level receiving both internal and external environment information for its assessment of performance, goal determination, and assessment of the future. This latter point introduces a third issue; namely, that the goal-setters need to examine the possible futures of the organization. Analytic techniques exist to enable the simulation of events through time which enhance the analysis of future effects by reducing uncertainty and projecting trends. A fourth issue concerns the

conscience of the organization, or the recognition of a code of conduct which is set, formally or informally, by the higher management level.

We may try to stand outside ourselves, outside our brains and our firms, and to survey the thing that we are. This operation, for a man, is often called an examination of conscience. And indeed I have heard a particular official in various companies referred to as "the conscience of the firm." But I prefer to talk about this faculty as the higher management [4:285].

It is not the purpose of this research to elaborate on this issue of moral responsibility of organizations, except to acknowledge that it is relevant and important to the System Five--Board Level of management. Finally, a fifth issue: the issue of survival. ". . . the ultimate criterion of viability must indeed be the capability to survive [4:283-284]." Systems science reveals that the basic purpose of any system, a business system or any other system, is survival. On the basis of information available, the system performs in a way that it perceives as maximizing the probability that it will survive (14:2). The notion of survival is a strong driving force within organizations.

The issues discussed here are correlated to the style of leadership exerted by the top level managers. They are equally applicable to SORO Division as they are to organizations in general. SORO Division is concerned with its survival; a code of conduct; the need to assess the impact of goals on the performance of the organization; and, recognizes that goal setting is an important high level

intellectual activity. The difficulty for SORO Division is in creating an environment in which these can be performed.

System Five requires the capability to evaluate goals and new policies for SORO Division. This is achieved by incorporating every feature of the Division in its environment which seems relevant to a consideration of its long-term future. It must be capable of reflecting new departures in policy. The technique for achieving this is rapid simulation which can be used to test policies against combinations of possible futures and map out viable strategies (5:43).

Two computer simulation languages exist for use by System Five; namely, DYNAMO and GASP IV. DYNAMO is a language for translating and running continuous models (models described by a set of differential equations). It was developed by the industrial dynamics group at the Massachusetts Institute of Technology for simulating dynamic feedback models of business, economic, and social systems (22:vii). The significance of DYNAMO and GASP IV is that they form the basic simulation languages for the important topic called Systems Dynamics or Industrial Dynamics.

Industrial Dynamics is the study of the information-feedback characteristics of industrial activity to show how organizational structure, amplification (in policies), and time delays (in decisions and actions)

interact to influence the success of the enterprise. It treats the interactions between the flows of information, money, orders, materials, personnel, and capital equipment in a company, an industry, or a national economy. Industrial dynamics provides a single framework for integrating the functional areas of management--marketing, production, accounting, research and development, and capital investment. It is a quantitative and experimental approach for relating organizational structure and corporate policy to industrial growth and stability [17:13].

The intent of emphasizing industrial dynamics is to indicate that techniques exist which enable policy models to be developed, and which allow policies to be simulated over time. The techniques underlying both Industrial Dynamics and GASP IV--Simulation of System Dynamics can be usefully applied to System Five, and SORO Division; however, it is not the intention to describe the basis of System Dynamics in this research.

SORO Division does not have a goal-setting capability or policy evaluation mechanism as described. In many instances existing policies are the same as those that existed prior to the introduction of new technology weapon systems (F111C, P3C, C130H). In addition, there are no policies in existence, or under evaluation, that concern resources management in the event of financial, or energy constraints being imposed by the external environment.

To establish the capability to meet the goal setting and policy determination needs of SORO Division, a substantial investment in computer simulation technology is necessary. This does not mean that it is immediately

required; but, that the capability to perform in this way may become a necessity. In the meantime, SORO Division can improve its goal-setting and policy development by utilizing its managers (existing Section Heads) to fulfill the System Five role.

System Five--Relevance

The relevance of System Five--Board Level to SORO Division is as follows:

1. SORO Division does not have effective machinery for setting or reviewing corporate goals or policies.
2. Current goals and policies have not been reviewed by a formal review structure.
3. Within the existing organization of SORO Division it is not possible to formulate effective goals and policies; because, the information on which these would be based is fragmented across the depot level facilities and dispersed among the individual managers.
4. Goal setting has become the role of the Section Heads. A situation that exists by default and which is undesirable, because individual Section interests are presented, which may not always coincide with the corporate interests.
5. A considerable investment in personnel; the development of the capability; and, techniques may be required for the development of this System.

A Proposed Organization Design for SORO Division

The preceding work was aimed at mapping the management cybernetic paradigm onto SORO Division. Now that it has been completed, it is possible to propose an organization design for SORO Division.

Proposal

The proposal is that SORO Division be organized in terms of the management cybernetic paradigm developed by Stafford Beer, and as applied in this research thesis.

Organization Structure

It is important to stress at this point that, while the words "organization structure" are used, the reader is cautioned not to confuse this with the conventional organization chart of hierarchy and authority. The structure that results from the application of cybernetics is physiological and not anatomical. The latter shows functions or people and their responsibility relationships, while the former is related to the effective communication and control of information throughout the organization.

The proposed organization for SORO Division is shown at Figure 14--Proposed Staff Officer Repair and Overhaul Division Organization. There are five Divisions; viz, No 1 Aircraft Depot/Ground Equipment Maintenance Squadron; No 2 Aircraft Depot; No 3 Aircraft Depot; Australian

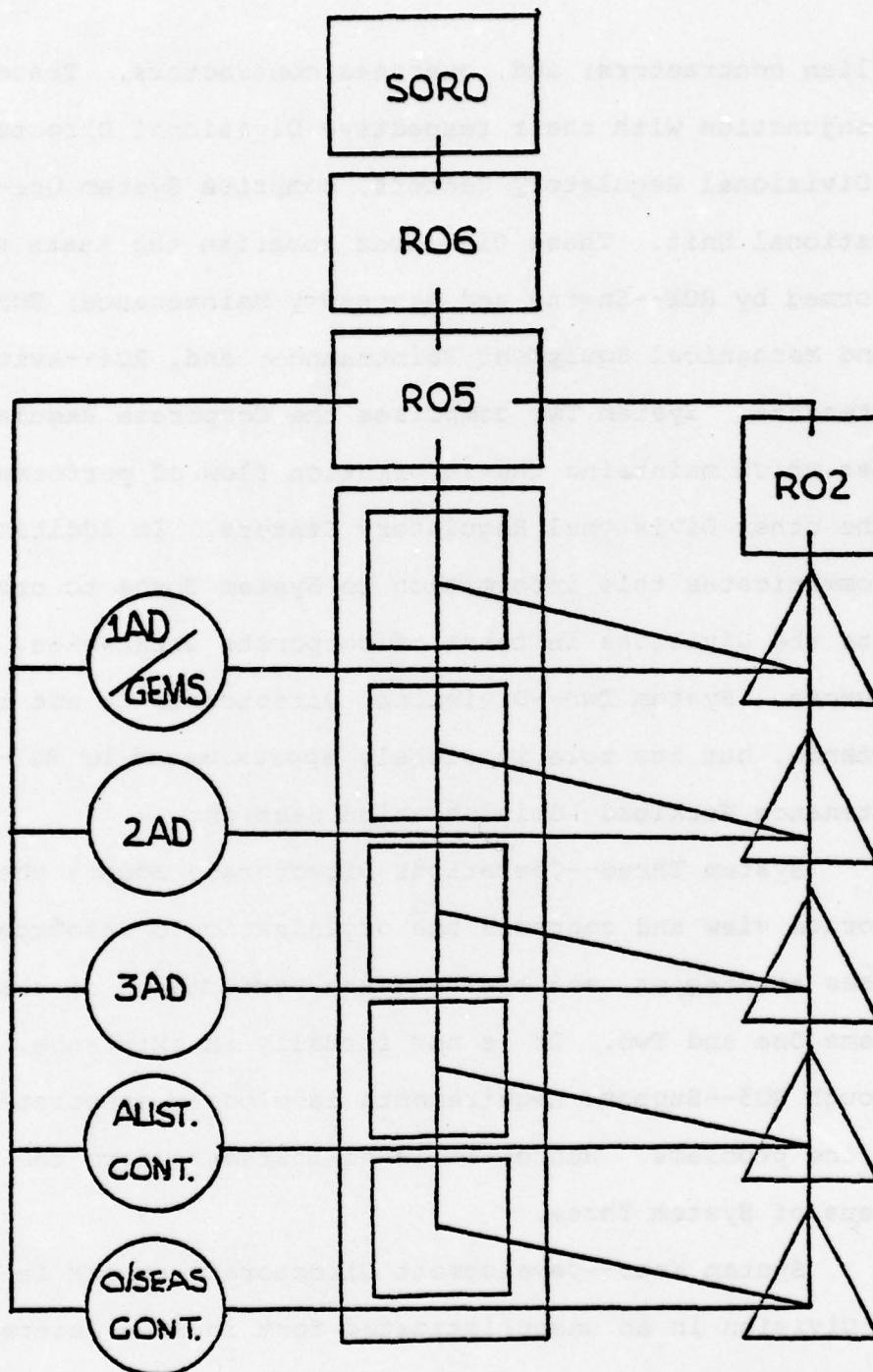


Fig. 14. Proposed Staff Officer Repair and Overhaul Division Organization

civilian contractors; and, overseas contractors. These, in conjunction with their respective Divisional Directorates and Divisional Regulatory Centers, comprise System One--Operational Unit. These Divisions comprise the tasks now performed by RO1--Engine and Accessory Maintenance; RO3--Ground Mechanical Equipment Maintenance; and, RO4--Avionics Maintenance. System Two comprises the Corporate Regulatory Center which maintains the information flow of performance to the other Divisional Regulatory Centers. In addition, it communicates this information to System Three to orchestrate the Divisions in terms of corporate strategies, and resources. System Two--Divisional Directorate is not in existence, but its role is closely approximated by RO2--Maintenance Workload Administration Section.

System Three--Operations Directorate adopts the corporate view and controls the organization's resources, devises strategies, and monitors the performance of the Systems One and Two. It is not formally in existence, although RO5--Support Requirements is closely associated with the problems. Hence, it is nominated to form the nucleus of System Three.

System Four--Development Directorate exists in SORO Division in an unsophisticated form in RO6--Maintenance Procedures Development. To meet the requirements of System Four, RO6 Section requires a capability to model the organization, either mathematically or cognitively.

Furthermore, it needs to be aware of the organization's external environment changes, and have a method for communicating these upward to System Five and downward to System Three.

System Five--Board Level is represented by the corporate system managers, as required. The Board includes the Staff Officer Repair and Overhaul (SORO), who may constitute its only member. However, it is the prerogative of System Five to utilize other system managers.

The discussion of System Five concludes the application, evaluation and analysis of the management cybernetic paradigm to SORO Division of the Royal Australian Air Force. The next chapter presents the conclusions and recommendations of this research.

CHAPTER V

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

The conceptual framework we were using changed the way that both government and industry looked at their problems. As the practical tools became available that enabled both to deal with tasks of allocation and distribution, and to face emergencies occasioned by local shortages and even widespread strikes, the people responsible found that the basic model [management cybernetic paradigm] made sense in active service. The process of innovation became a dynamic drive.

— Stafford Beer [9:13]

This chapter represents the final chapter for this research study. It is intended to summarize the research objectives, research questions, and to present the conclusions and recommendations of the research team.

Research Objectives

The objectives established by the research team for this study were:

1. To establish a methodology for the application of Stafford Beer's management cybernetic paradigm.
2. To apply Stafford Beer's management cybernetic paradigm to Staff Officer Repair and Overhaul Division of the Royal Australian Air Force.
3. To propose an organization design for SORO Division in terms of the management cybernetic paradigm.

Research Objective One

This objective was established to provide managers with a procedure for bridging the gap between theory and practice. Most managers have extensive experience in their own field and are conscious of the reality of their problems. The same managers are not always comfortable with theory--despite the volume of management texts, seminars, discussions, journals and courses that are available, and that they attend. Therefore, the research team set the objective to build the bridge between the two positions. The achievement of this objective is shown in Chapter III--Methodology, under the heading, The Application Process.

Research Objective Two

The intention of research objective two was to use SORO Division as a vehicle for applying the management cybernetic paradigm proposed by Stafford Beer. The motives for such an intention were as follows:

1. Recent experiences in SORO Division indicated that it had significant organizational problems; but, agreement could not be reached on a methodology for addressing them.

2. The management cybernetic paradigm was not well understood by the research team in the beginning, and it was most helpful to have a familiar organization for

comparison, and as a basis for understanding the principles expressed in this research.

3. SORO Division fulfills a complex function, but is not a big or unwieldy organization. The contention being that if the paradigm could be successfully mapped onto SORO Division, it could be applied to larger systems and organizations.

4. The management cybernetic paradigm, as proposed by Stafford Beer in his book Brain of the Firm (1972), is still relatively new in that there are few accounts of cybernetics outside of his books. Therefore, the research team was motivated to apply the paradigm in a scientific way to show its suitability to any organization; but, more significantly, to bureaucracy.

Research Objective Three

The outcome of the previous two objectives was expected to lead to the mapping of the paradigm onto SORO Division. Provided this was successful, the research team expected that it could propose an organization structure for SORO Division based on the management cybernetic paradigm. This objective was achieved and is recorded in Chapter IV--Application, Analysis and Evaluation.

Research Questions

The preceding research was conducted to: (1) apply the management cybernetic paradigm, as proposed by

Stafford Beer in his two books, Brain of the Firm, and Decision and Control; and (2) to gain an understanding of his proposed management cybernetic paradigm, and other cybernetic principles, through the process of applying it to an existing and familiar organization. The research began from the tentative awareness that management theorists were not extolling its virtues, and that few had ever attempted to apply the proposed paradigm--either conceptually or practically. The question foremost in the minds of the research team was: How does the paradigm work and how can it be used? The application of the paradigm was limited to SORO Division of the Royal Australian Air Force, which was known to one member, who had spent three previous years in the same organization.

Research Question One

The first research question posed was: Is it possible to prescribe an organization design for SORO Division in terms of the management cybernetic paradigm? The conclusion reached by the research team is that it can be done. The mathematical skills exist; computer programming capability exists, and is possibly less complex than many centralized management information systems with their attendant data base problems; management theory widely accepts general systems theory and several modern books describe the principles of cybernetics and the management

cybernetic paradigm. All these factors, plus the ability to actually apply the paradigm gave the research team added confidence and enthusiasm that the management cybernetic paradigm is a most significant contribution to the world of management.

The mathematical skills required for use within the paradigm cover most existing operations research techniques. Their actual employment by an organization will depend on the field of involvement, and the skill of its employees. However, the problem for management is to find a skilled analytical group that understands cybernetics--and its application to social systems (complex organizations)--such that the mathematical basis for the computer programs can be defined and developed for general use. The research team is aware that CYBERSTRIDE, the statistical basis for processing the indices of Systems One and Two for the Chilean economy, was developed and exists. This program is a vital part of the operation of the paradigm.

Research Question Two

The second research question posed was: What specific structural changes are required to ensure that SORO Division processes are maintained or enhanced by the introduction of management cybernetics? This question was answered in the previous chapter and section discussion--
A Proposed Organization Design for SORO Division.

There are two important considerations: (1) leave the existing organization as it is except for minor changes to personnel locations, but change the roles to those proposed; or (2) change the existing configuration of personnel to align with the proposed systems and their roles. The former option is a conservative approach which implies uncertainty and hesitancy about implementing the paradigm. The second option is a positive move that indicates a clear understanding of the paradigm.

Managers will be reluctant to support option two. This reluctance is supported, simply because SORO Division needs to employ the services of an Operational Research team of interdisciplinary members to work with its managers to develop the techniques and skills that are applicable. This cannot be achieved by requesting management consultants to provide a solution without an awareness of the purpose and character of SORO Division.

The importance of this research is that it defines the context of SORO Division's activities and functions, and clearly indicates the type of techniques to be employed. In effect, it provides SORO Division with an outline of what is required and why; as opposed to not knowing what is required.

For SORO Division to implement the findings of this research study, it could conservatively adopt option one

until it was confident that the results justified a further investment of an Operational Research team study.

Research Question Three

The third research question posed was: How can SORO Division's performance be measured? This question was answered in Chapter IV and the Section--Description of the Management Cybernetic Paradigm for SORO Division.

Most organizations discuss the notions of performance and effectiveness, and many methods have been developed. In the management cybernetic paradigm, there are three measures: Potentiality, Capability, and Actuality that relate the value of actual achievement to desired levels. These measures are further utilized to produce three values for Performance, Productivity and Latency. Figure 12 indicates the indices referred to and shows their relationship to one another. The figure also indicates three forms of planning that are directly related to these indices. Normative planning is related to Potentiality; Planning by Objectives (strategic) planning is related to Capability; and, Programming (tactical) is related to Actuality.

The relationships described provide a way of evaluating actual achievement to expectations, and relates corporate planning to these indices. In effect, if SORO Division developed the variables that revealed information

about its performance or achievements, it would have a robust method of performance measurement. Furthermore, it could use the same measures (but, in the form of pure numbers) to develop corporate plans.

Certain variables were presented and discussed in this research. These were presented because of recent experience with SORO Division, but there are others that were not mentioned (e.g., morale--absenteeism) that may be important to monitor. The research study takes a conservative stand on this issue, simply because the imposition of set variables is the role of the individual workers and managers to decide. It is not the intention of this research study to usurp that prerogative.

The performance of SORO Division can be measured by using the method described in this research. To monitor the variation in these measures and to use them as a basis for decision taking, is the concern of statistical analysis, using existing knowledge and Bayesian probability theory to detect trends. On this point, the mathematical theory exists and a computer program (CYBERSTRIDE) has been developed as part of the application of cybernetics to the social economy of Chile; but, no formal account of that application has been published.

Conclusions

The conclusions reached by this research are:

1. That understanding the application of cybernetics to complex organizations requires a comprehensive appreciation of systems theory. In addition, it requires an understanding of the principles of cybernetics. In short, managers need to view their organizations in terms that, as yet, are not part of the existing body of management knowledge.
2. That the lack of comprehension of management cybernetics can be compensated, in part, by the skillful application of the management cybernetic paradigm.
3. That the application of cybernetics to management is a significant step toward establishing important principles for management, which until its advent contained few scientific principles.
4. That the management cybernetic paradigm developed by Professor Stafford Beer is not a model. It is a paradigm that can be applied to a variety of organizations. A model is an abstraction of reality that requires historic data for the study of a desired behavior or characteristic. In this sense, a model of an organization does not serve the same purpose as the cybernetic paradigm. Therefore, its validation is not that it reasonably approximates the real world situation, but that it survives by continuous adaptation to the real world. This understanding

of the difference between a model and the management cybernetic paradigm is important.

5. That management cybernetics can be applied to a complex organization; namely, Staff Officer Repair and Overhaul Division of the Royal Australian Air Force.

6. That an alternate organization structure for the Staff Officer Repair and Overhaul Division can be proposed.

7. That the performance, productivity and latency of the Staff Officer Repair and Overhaul Division is an intrinsic benefit gained from the application of cybernetics.

8. That the development of the mathematical programs necessary for the statistical processing of the indices can be achieved within the existing body of mathematical knowledge and computer technology.

9. That the variables used by the Staff Officer Repair and Overhaul Division be recommended by the managers concerned and in conjunction with an interdisciplinary operational research team.

10. That the functions, position, and interfaces of the Staff Officer Repair and Overhaul Division, within Headquarters Support Command, make it a complex organization. Its problems have a corresponding complexity that cannot be reduced by the isolated development or adaptation of mathematical models.

11. That the complexity of SORO Division requires the specific application of computer technology to the processing of the achievement and performance indices, plus mathematical techniques discussed in this research study.

Recommendations

The recommendations of this research study are:

1. That a study be conducted for the purpose of developing the mathematical programs necessary for the processing of an organization's variables to produce the indices described in Professor Stafford Beer's books Brain of the Firm, and Decision and Control.

2. That a study be conducted to describe the development and application of normative planning, planning by objectives (strategic), and programming (tactical) in a cybernetic firm.

3. That SORO Division identify those variables that are considered important to its performance and survival.

4. That SORO Division recognize the importance of resources management and take action to manage its resources as a corporate function.

5. That mathematical techniques (linear programming, multiple linear regression, statistical analyses, etc.) be studied by a competent operational research team for their application to SORO Division in keeping with the requirements of System Three, System Four and System Five.

The recommendations proposed are not bound by a time period, but are contingent upon the understanding and acceptance of management cybernetics as a scientific basis for structuring organizations, and the use of existing mathematical techniques within a cybernetic framework or firm. Hence, for all the scientific research that is represented by this research study, its successful adoption is still dependent upon the recognition of need:

For unless the point is taken that something has to be done, the upheaval imposed by the remedy (however attractive it may look in its own right) will seem too much [4:246].

SELECTED BIBLIOGRAPHY

A. REFERENCES CITED

1. American Heritage Dictionary. Boston: Houghton, Mifflin Company, 1976.
2. Australian Department of Defence. "Management Systems Study Group Final Report, 30 September 1977." Melbourne: Headquarters Support Command, File Reference 3051/2/4 Tech.
3. Barnard, Lance. Australian Defence: Report of the Reorganization of the Defence Group of Departments, presented to the Australian Parliament, November 1973. Canberra: Australian Government Publishing Service, 1973.
4. Beer, Stafford. Brain of the Firm. New York: Herdes and Herdes, 1972.
5. _____. "Concerning the Cybernetic Paradigm for Organizing the Firm." Unpublished research paper, undated.
6. _____. Decision and Control: The Meaning of Operational Research and Management Cybernetics. New York: John Wiley and Sons, 1974.
7. _____. Designing Freedom. London: John Wiley and Sons, 1974.
8. _____. Platform for Change. London: John Wiley and Sons, 1975.
9. _____. "The Zaheer Lecture: Cybernetics of National Development: Evolved from Work in Chile," as presented to the Zaheer Science Foundation, New Delhi, on 5 December 1974.
10. Blanchard, Benjamin S. Logistics Engineering and Management. Englewood Cliffs NJ: Prentice-Hall, Inc., 1974.
11. Bronowski, J. Science and Human Values. New York: Harper and Row, Publishers, 1959.

12. Bushell, E. J., Group Captain, Royal Australian Air Force. "Some Basic Thoughts on Organization Structure and the Position of Logistics Support in the RAAF." An unpublished paper. Melbourne: Headquarters Support Command. File Reference, 2901/18/201, Part 3 of 28 November 1977.
13. _____. "Working Party Report--Presentation on Management Requirements for the Preparation of Engineering and Maintenance Management EDP Specifications, 24-25 May 1976." A report submitted to Air Force Office, 24-25 May 1976. Melbourne: Headquarters Support Command. File Reference, 2901/18/201-2 Tech.
14. Christopher, William F. "New Systems Science Approaches for Corporate Planning." A paper presented at the 6th International Conference on Planning, Honolulu, November 14, 1977.
15. Collins, W. M., Wing Commander, Royal Australian Air Force. "An Organization Oriented Toward Functions or Products? A Systems Approach to the Form and Structure of Headquarters Support Command." An Unpublished thesis presented to the RAAF Staff College, Canberra, 1976.
16. Coyle, R. G. Management System Dynamics. New York: John Wiley and Sons, 1977.
17. Forrester, Jay W. Industrial Dynamics. Cambridge MA: The MIT Press, 1977.
18. Fuller, R. Buckminster. Operating Manual for Spaceship Earth. New York: P. T. Dutton, 1971.
19. Kast, Fremont E., and James Rosenzweig. Organization and Management: A Systems Approach. 2d ed. New York: McGraw-Hill, 1974.
20. Mayo, Bernard. Jefferson Himself. New York: Houghton Mifflin Co., 1976.
21. Ostrom, Lonnie L., Captain, USAF, and Graham W. Rider, Lieutenant Colonel, USAF. "A Military Logistics Concept Applied." Readings in Contemporary Military Logistics Policy and Planning--Volume 1. Air Force Institute of Technology, School of Systems and Logistics, WPAFB OH, 1977.
22. Pugh, Alexander L. III. Dynamo User's Manual. Cambridge MA: The MIT Press, 1976.

23. Royal Australian Air Force. "Annual Maintenance Programme-Planned Workload Analysis Report, 1976."
Melbourne: Headquarters Support Command, 1976.
24. _____. Headquarters Support Command Maintenance Procedures, AAP7001.036.1. Amendment List 3, 5 May 1978. Melbourne: File Reference 2500/410/26 Tech Ptl.
25. Schoderbek, Peter P., Asterios G. Kefalas, and Charles G. Schoderbek. Management Systems: Conceptual Considerations. Dallas: Business Publications, Inc., 1975.
26. Schwember, Hermann. "Cybernetics in Government: Experience with New Tools for Management in Chile 1971-1973," in Concepts and Tools for Computer-Assisted Policy Analysis: Vol. I--Basic Concepts. Hartmut Bossell, ed. Unpublished manuscript, undated.
27. Sutherland, John W. Administrative Decision-Making: Extending the Bounds of Rationality. New York: Van Nostrand Reinhold Company, 1977.
28. _____. Systems Analysis, Administration, and Architecture. New York: Van Nostrand, Reinhold Company, 1975.
29. Van Gigch, John P. Applied General Systems Theory. 2d ed. New York: Harper and Row, Publisher, 1978.

B. RELATED SOURCES

- Ackoff, Russell L. "Towards a System of Systems Concepts," in System Analysis Techniques, Robert W. Knapp and J. Daniel Couger, eds. New York: John Wiley and Sons, 1974.
- Barnard, Chester I. The Functions of the Executive. Cambridge MA: Harvard University Press, 1938, as quoted in Fremont E. Kast, and James E. Rosenzweig, "General Systems Theory: Applications for Organization and Management," Academy of Management Journal, Vol. 15, No. 4 (December 1972), p. 448.
- Beer, Stafford. Cybernetics and Management. 2d ed. London: The English University Press Ltd., 1971.

- Bennis, Warren G. "The Coming Death of Bureaucracy." An article in H. E. Frank, Organizational Structuring. London: McGraw-Hill, 1971.
- Boulding, Kenneth. The Image, University of Michigan Press, 1961, as referenced in William B. Scott, "Organization Theory: An Overview and an Appraisal," Journal of the Academy of Management, Vol. 4, No. 1 (April 1961), pp. 7-26, as reprinted in Peter P. Schoderbek, ed., Management Systems: A Book of Readings. New York: John Wiley and Sons, Inc., 1967.
- Christopher, William F. The Achieving Enterprise. New York: American Management Association, 1974.
- Dechert, Charles R. "The Development of Cybernetics," The American Behavioral Scientist, June 1965, pp. 15-20, as reprinted in Peter P. Schoderbek, ed., Management Systems: A Book of Readings. New York: John Wiley and Sons, Inc., 1967.
- Falconer, Norman R., Major, USAF. "A Systems-Logistics Manager Concept for RAAF Logistics Management (A Proposal)." An unpublished staff paper submitted to Air Force Office, Canberra, 1977.
- Killen, D. J. Australian Defence White Paper, presented to the Australian Parliament in November 1976. Canberra: Australian Government Publishing Service, 1976.
- Latil, Pierre de. Thinking by Machine. Boston: Houghton Mifflin Company, 1957.
- Pask, Gordon. An Approach to Cybernetics. New York: Harper and Brothers, 1961.
- Perrow, Charles. Complex Organizations--A Critical Essay. Palo Alto: Scott, Foresman and Company, 1972.
- Pugh, D. S., ed. Organization Theory. Middlesex: Penguin Books, 1974.
- Weinberg, Gerald M. An Introduction to General Systems Thinking. New York: John Wiley and Sons, 1975.
- Weiner, Norbert. The Human Use of Human Beings. Boston: Houghton Mifflin Company, 1950.

Royal Australian Air Force. "A Presentation of SORO Division Functions to Officers Attending Introductory Engineer Courses." Melbourne: Headquarters Support Command, 1978.

_____. Defense Instructions (Air Force) Technical. Canberra: Australian Government Publishing Service, undated.

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